

# The Chemical Age

VOL LXIV

6 JANUARY 1951

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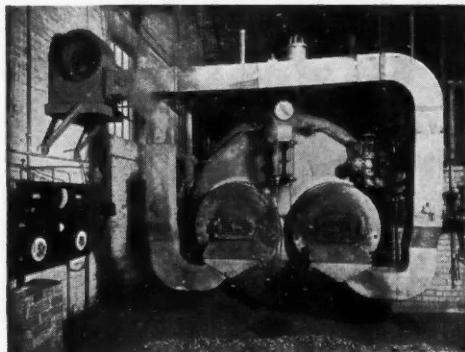
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## INDEX TO ADVERTISERS IN THIS ISSUE

	Page		Page
Airey, Robert & Son, Ltd. Altringham Jute Ltd.	xi 39	Imperial Typewriter, Co., Ltd.	xii
Black, B. & Son, Ltd.	xi	Jenkins, Robert & Co., Ltd.	viii
Blackwell's Metallurgical Works, Ltd.	28	Kestner Evaporator & Engineering Co., Ltd.	Cover iv
British Electrical Development Association	35	Kilner John & Sons (1927), Ltd.	39
Burgess Zeolite Co. Ltd.	Cover iii	Lennox Foundry Co., Ltd.	xii
Chemapol Ltd.	39	Manlove, Allott & Co., Ltd.	v
Chemical Engineering & Wilton's Patent Furnace Co., Ltd., The,	iii	Muirhead & Co., Ltd.	i
Classified Advertisements	40, ix & x	National Enamels, Ltd.	20
Derbyshire Stone, Ltd.	37	Nitralloy, Ltd.	xii
Donkin, Bryan, Co., Ltd., The,	Cover iv	Organic Dyestuffs Ltd.	vii
Dryden, T., Ltd.	20	Philips Electrical, Ltd.	vii
Electro-Power Service Co., The,	39	Price, Stutfield & Co., Ltd.	Front cover
Farwig, J. F. & Co., Ltd.	iv	Robinson, L. & Co. (Gillingham), Ltd.	iv
Fielding, T. H. & Sons, Ltd.	xii	Sandiacre Screw Co., Ltd., The,	20
Four Oaks Spraying Machine Co., Ltd., The,	Cover iii	Steele, G. W. & Co.	x
Glebe Mines, Ltd., Guest Industrial Ltd.	Cover ii Cover ii & x	Sutcliffe, Speakman & Co., Ltd.	ii
Houchin Ltd.	Cover iii	Swift & Co., Ltd.	xi
		Unifloc, Ltd.	viii
		Wells, A. C. & Co., Ltd.	Cover ii
		Wilkinson, James & Son, Ltd.	xi

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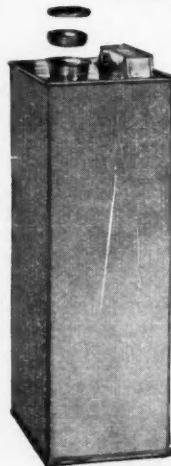
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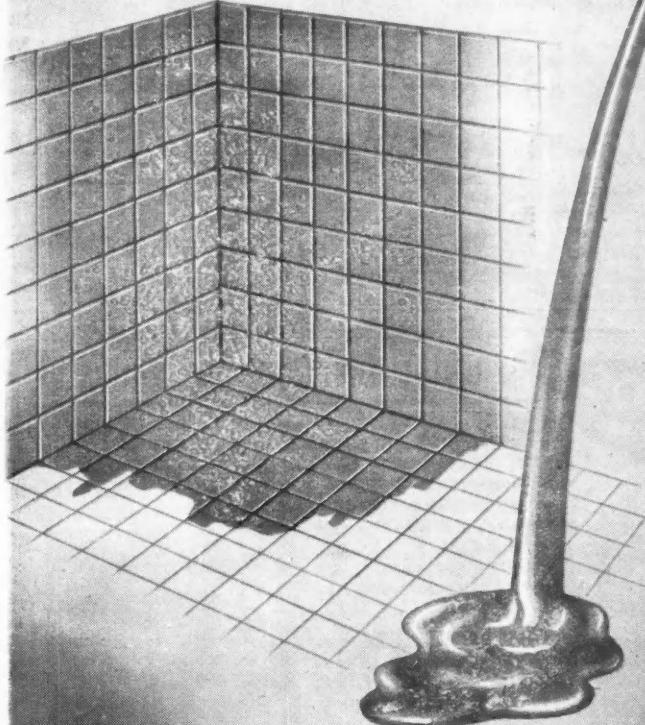
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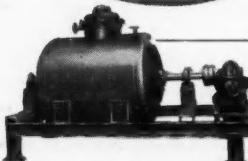
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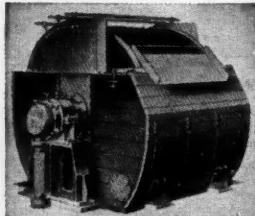
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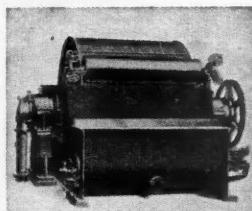
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6 January 1951

Number 1643

## Technological Education

ONCE again attention has been focused upon the problems of technological education. In the latest issue of the *Journal of the Royal Institute of Chemistry* (1950, 74, 6) the recent proposals of the National Advisory Council are criticised in some detail by the R.I.C. Council. At first sight the differences in opinion do not seem great, appearing to consist mainly in different judgments as to the most useful first step towards expanding technological education. But in truth the issues of disagreement lie deeper. The Advisory Council in its published proposals of last October placed a major emphasis upon the nature or status of the award for technological students. Unless the final award was equivalent in standing to a university degree or to corporate membership of a professional institution, it was feared that students would not be attracted to courses in technological subjects. The R.I.C. takes the view that the nature of the award is not of major importance. As a criticism this may be a difficult point sustain. It is true that letters after names and their meanings are readily ignored by established scientists; they are little more than ancient tickets of admission or passports. But to the young man seeking a career and opportunities the

right to place some hallmark after his name in return for several years of disciplined study is of the greatest importance; without it many doors must remain closed. It is difficult to believe that the R.I.C. Council is unaware of this very human aspect of professional awards; especially as this body's more detailed criticisms show that in fact it attaches the utmost importance to the nature and status of technological awards.

A new body, to be called the Royal College of Technologists, will give three grades of awards—Associateship, Membership, and Fellowship. The lowest and first of these will rank with a university degree in status. The awarding of diplomas or certificates has been rejected because neither would "suggest an award which is equivalent in status to university awards". Degrees, too, have been rejected because they would be unlikely to receive the support of the universities. No one can blame the Royal Institute of Chemistry for sensing danger in these proposals. Its own long-established and proven system of awards has been selected as the model; direct comparisons are inevitable but there is no common yardstick of measurement. Will it be possible to draw some boundary between the genuine tech-

nologist and the skilled technician? Had the Report not rejected the awarding of diplomas or certificates, the means of creating such a distinction would have been to hand. Is the important and by no means small class of technicians to be left without an appropriate award? Or will the technological Associateship eventually serve this purpose? There are no safeguards. At present all technologies in which chemistry is a major science—are covered by the recognised awards of the R.I.C. The Associateship is available by examination; its award denotes a sound basic knowledge of chemistry. The Fellowship, particularly in the last ten years, is frequently awarded to chemists whose work has been of a specialised nature involving contributions to branches of applied or industrial science. For all such technologies it is unlikely that any new system of award will carry the status of this already established and accepted system. It may be argued that in some subjects of industrial science the total knowledge of science required by a sound technologist may be quite as high, yet not in any single subject—chemistry, engineering, physics, etc.—sufficient to obtain recognition by an existing institution. This is surely

somewhat theoretical. Will lesser acquaintance with these fundamental subjects produce a genuinely useful industrial scientist? And would not such cases always be, as they have been in the past, exceptional and ultimately recognised by the professional institutions? If, indeed, some branches of technology embrace a number of fundamental sciences so that qualification in one of them is difficult to secure at an early age, is it logical to envisage some system by which the label "technologist" can be fastened on to a young man in the early twenties?

The Council of the Royal Institute of Chemistry must be respected for its critical stand against the 1950 proposals. No constructive purpose will be served in the end if the new technological awards fall below the standards of the older scientific awards; however impressive this newish word "technologist" may sound, there is a limit beyond which the "Jack-of-all-trades" argument cannot be soundly pressed. No one doubts that the facilities for technological education must be greatly expanded and improved; but at least to begin with the awards to students should be made by the established institutions of science.

## On Other Pages

### Leader :

<i>Technological Education</i>	. . . . .	1
--------------------------------	-----------	---

### Notes and Comments :

<i>Swiss Scientific Research</i>	. . . . .	3
<i>Plans for Zinc</i>	. . . . .	8
<i>Zinc Shortages—The Reason</i>	. . . . .	4
<i>Zinc and Copper Restrictions</i>	. . . . .	5
<i>British Achievements in Steel Technology</i>	. . . . .	7
<i>The Wrong Kind of Research</i>	. . . . .	10
<i>Canada's Metals and Minerals</i>	. . . . .	11

<i>Production Gains in Germany</i>	. . . . .	13
------------------------------------	-----------	----

<i>The Determination of Zinc</i>	. . . . .	15
----------------------------------	-----------	----

<i>Chemical Engineers Examination</i>	. . . . .	17
---------------------------------------	-----------	----

<i>Acid Colorimetric Test for Metals</i>	. . . . .	19
--	-----------	----

### METALLURGICAL SECTION

<i>Pure Metals by the Amalgam Process</i>	. . . . .	21
<i>Ageing of Aluminium Alloys</i>	. . . . .	25

<i>Bookshelf</i>	. . . . .	30
------------------	-----------	----

<i>Personal</i>	. . . . .	31
-----------------	-----------	----

<i>Next Week's Events</i>	. . . . .	34
---------------------------	-----------	----

<i>The Stock and Chemical Markets</i>	. . . . .	38
---------------------------------------	-----------	----

## Notes and Comments

### Swiss Scientific Research

THE important achievements of Swiss scientists—who have included some winners of the Nobel Prize—and Switzerland's fine universities and technical colleges, are appreciated the world over. However, it is significant that a group of prominent Swiss businessmen and scientists is much concerned about the problem of how to maintain the high reputation of Swiss scientific research work under present conditions. In a characteristically Swiss manner, this group has taken the initiative to propose the establishment of a Swiss National Fund for the Promotion of Scientific Research. The aim of the proposed organisation will be to further fundamental scientific research. It will not be concerned with applied or industrial research which is at present looked after extremely well in Switzerland, for, to give one example only, the CIBA Group is spending no less than Swiss francs 12 million annually for this purpose. The sponsors of the Fund have submitted a memorandum to the Federal authorities, stating that Swiss scientists have followed with great interest the large-scale State promotion of scientific research in all civilised countries of the world and that this observation has made them concerned about the insufficiency of the means for research work at Switzerland's disposal. The memorandum also states that there is a danger that Swiss scientific work might become inadequate or retarded. To avoid such a calamity, the sponsors of the scheme have asked the Federal authorities for an outright grant of one million Swiss francs, and for an annual subsidy of four million Swiss francs for five years. Altogether they want 21 million Swiss francs, spread over five years. It is hoped that the Swiss authorities and the Swiss public will give full approval to this important and far-reaching proposal. There can be no doubt that the further promotion of fundamental scientific research work in Switzerland would

stimulate in a beneficial way research work beyond its frontiers.

### The Plan for Zinc

THE decision taken by the Ministry of Supply to restrict the use of zinc, copper and brass in certain "non-essential" manufactured goods seems reasonable, and within its limits, as fair as possible under the circumstances. Some sections of industry will be, of course, affected far more than others but at least the system of control will be worked by the industry itself and not by Government departments. This will make for flexibility and—probably—the least inconvenience. In this respect Mr. Strauss is to be complimented on his scheme. But is he putting too much responsibility on the zinc suppliers? Officially, the Ministry's policy is to allow arms manufacturers 100 per cent of their requirements and the "non-essential" industries none. Between those limits there is room for plenty of speculation on the part of the zinc suppliers as to how much any particular firm is to get. It seems highly reasonable therefore, that at least some of their decisions will not be well received. Perhaps, once the scheme is under way, the Ministry will issue some kind of priority for the guidance of the suppliers of zinc. At the moment, however, the Ministry has not made the position clear, and, in fact, refuses to make its allocations for more than one month ahead. This is not going to make the industry's task any easier, although it is fair to say, in extenuation of the present policy, that there is no firm indication of what the demand for zinc will be, particularly in regard to armaments. The Ministry deals directly with only 600 firms of fabricators using zinc, and 2,000 using copper. It has only a vague idea as to the requirements of the many firms using zinc—or copper—in the course of making products other than those fabricated directly from the metals themselves. Mr. Strauss admitted his department had no accurate

picture of how much zinc would be conserved by the new regulations, only that amount would be significant. He thought that there would probably be redundancy or unemployment in some areas but he could not estimate to what extent. So it will be seen that his scheme is rough and ready, and likely, for a time at any rate, to be a rather impromptu affair. But, though drastic, the new measures will ensure that at least rough justice is done. The community, rather than certain sections of it, will share the burden.

### Zinc Shortages—The Reason

**B**LAME for the present shortages of materials, particularly zinc, was attributed by Mr. G. R. Strauss, Minister of Supply, to the results of the war in Korea, speaking at a Press conference last week. Before hostilities began there, neither the Government nor the zinc consumers felt any concern about future zinc supplies but since June the situation had

deteriorated. Many industries and Governments were trying to build up stocks of zinc and this had led to the current world shortage. As far as Great Britain is concerned, however, Mr. Strauss indicated, the present position is due in no small measure to the failure of Belgium to deliver a large consignment of zinc during this quarter; there is no clear idea when, in fact, it will be delivered. The Minister emphasised that lack of hard currency was not a contributing factor to the present shortage; we were willing to buy zinc, but there was little for sale. There is no doubt that Mr. Strauss is beset by many difficulties, but it is the duty of his department to "deliver the goods." Excuses, however, justified, will not ease the position. The Ministry must do its utmost to see that, if any small parcels of zinc become available, they are snapped up for British use. Those who sell zinc will scratch around and find some more—if the price is right.

## British Plastics Exhibition

**M**ORE than 60 firms, including most of the well-known names in each section of the industry in Great Britain, have arranged to show their products at the British Plastics Exhibition and Convention, to be held in London from 6 to 14 June. The whole of the space on the ground floor of the National Hall, Olympia, is already allotted and the first floor is now being filled up.

A feature of special public interest on the first floor of the exhibition, entitled "The Story of Plastics," is being sponsored jointly by the organisers, the British Plastics Federation and the Council of Industrial Design. The exhibit is designed to demonstrate the chief properties and applications of plastics and to widen public understanding of their importance.

Subjects for discussion at 15 sessions of the Convention are now announced and a list of speakers, chairmen and titles of papers will be available later. Morning sessions, from which the public will be excluded, will be devoted to scientific and technical papers on subjects such as progress in materials, developments in plant and equipment and fabrication techniques.

The provisional programme is as follows:

**Wednesday, 6 June.**—Inaugural lecture: "The Place of Plastics in Industry."

**Thursday, 7 June.**—10.15 a.m.-12.30 p.m.—"Progress in Plastics Materials." 2.30 p.m.-4 p.m.—"Plastics in the Chemical Industries." 5 p.m.-7.30 p.m.—Films.

**Friday, 8 June.**—10.15 a.m.-12.30 p.m.—"Vinyl Formulation and Compounding." 2.30 p.m.-4 p.m.—"Plastics in the Textile Industries." 5 p.m.-7.30 p.m.—Films.

**Saturday, 9 June.**—10.15 a.m.-12.30 p.m.—Forum: "Buying and Selling."

**Monday, 11 June.**—10.15 a.m.-12.30 p.m.—"True Synthetic Fibres." 2.30 p.m.-4 p.m.—"Plastics in Building and Architecture." 5 p.m.-7.30 p.m.—Films.

**Tuesday, 12 June.**—10.15 a.m.-12.30 p.m.—"Developments in Synthetic Resins." 2.30 p.m.-4 p.m.—"Housewives' Quiz." 5 p.m.-7.30 p.m.—Films.

**Wednesday, 13 June.**—10.15 a.m.-12.30 p.m.—"Developments in Processing Plant." 2.30 p.m.-4 p.m.—"Plastics in the Transport Industries." 5 p.m.-7.30 p.m.—Films.

**Thursday, 14 June.**—10.15 a.m.-12.30 p.m.—"Techniques of Fabrication." 2.30 p.m.-4 p.m.—"Plastics in Surgery and Medicine." 5 p.m.-7.30 p.m.—Films.

**Friday, 15 June.**—10.15 a.m.-12.30 p.m.—"Plastics Film Production and Handling." 2.30 p.m.-4 p.m.—"Plastics in Packaging." 5 p.m.-7.30 p.m.—Films.

## ZINC AND COPPER RESTRICTIONS

**T**HE Minister of Supply announced in Parliament on 7 December that the shortage of supplies of all grades of zinc likely to be available to industry over 1951 would, so far as could be seen, involve further cuts in consumption and that out of the amount available, the increasing requirements of defence would have to be met. He explained that during the first quarter of the year the position was likely to be particularly serious, and that the supply of the ordinary grade of zinc might have to be restricted during that quarter to about 50 per cent of the 1950 rate.

At a Press conference on 28 December the Minister announced that although every effort was being made to increase supplies to this country, any further supplies that might be secured were likely to be wholly absorbed by increasing demands for defence purposes and so the Government must plan on the basis that the serious shortage in the first quarter of the year would continue for some time.

It was the policy of the Government to assure not only full supplies for rearmament, but also as much as possible for other uses important to the country's economy, particularly capital and other goods for the equipment of industry and valuable exports such as vehicles. Acute shortage in many of these fields would create bottlenecks which would have serious effects over a large section of industry.

### Maximum Saving is Necessary

To avoid this, the maximum saving would have to be made in the application of zinc to the less essential uses. The Government therefore intended to introduce in January a statutory Order prohibiting from 1 February certain specified uses of zinc and brass which are regarded as unjustifiable in present circumstances. There would be provision in this for licensed exemptions for special purposes. To prevent substitution of copper in these uses, and to conserve the supplies of this metal, the Order would include prohibition of certain uses of copper.

The provisional list of prohibited uses included zinc, copper and/or copper alloys used in the manufacture of household appliances, ornaments, gas and electrical equipment, architectural metal work, some galvanised tubes, fittings, sheets, wire and hollow ware, etc.

It had not been possible to consult all the manufacturing industries concerned. Meanwhile, in the application of the limited supplies of zinc which will be made available to them in January, galvanisers

and manufacturers of zinc and brass products were asked as far as practicable to discriminate in accordance with this indication of the Government's views. They were asked also to give preferential treatment to those applications of zinc or brass in which very small quantities are essential to the production of engineering goods of a high conversion value such as watches and scientific instruments.

The allocation of zinc would for the time being be made on a monthly basis. The February allocation would be determined in the latter part of January in the light of experience of the working of the January allocations and of any further developments in the supply position.

### Individually Notified

Purchasers of zinc from the Ministry were being individually notified by the Directorate of Non-Ferrous Metals of their allocations for January. The quantities of the three grades of zinc available for distribution in this way were the following percentages of the average monthly rate of consumption over the first nine months of 1950:

**Ordinary (G.O.B.)**—Used predominantly for galvanising and also for brass and zinc oxide—50 per cent.

**Electrolytic**—Used mainly in brass, rolled zinc products and zinc oxide—for brass 85 per cent, for other uses 70 per cent.

**High Purity**—Used mainly in die casting—85 per cent.

This worked out at about 60 per cent on the average over all grades.

Arrangements had already been made with the iron and steel industry to stop, save exceptionally, the galvanising of sheet and of scaffolding tube and to secure drastic economies in the galvanising of wire. Other galvanisers (i.e., general galvanisers) were asked, pending the introduction of the Prohibition Order, to observe as far as practicable the guidance given by the Government as to essential and inessential uses in the application of their limited zinc supplies.

A similar request was made to brass manufacturers (sheet and strip, wire, tube and castings) and to manufacturers of zinc rolled products.

Arrangements were being made by the Board of Trade with the zinc oxide manufacturers to curtail drastically the supply of zinc oxide for paint.

Die casters, who would receive 85 per cent of their average monthly consumption over the first nine months of 1950, were

asked to make a proportionate distribution to each of their customers.

The Government was anxious to avoid if possible the adoption of a fully detailed allocation scheme. This could only be done if manufacturers were able to distribute their zinc and brass products in accordance with the general guidance given above, although it was appreciated that this would be no easy task.

The zinc supply position had recently been aggravated by a falling off in the quantity of scrap available to industry. The Minister was proposing to take steps to deal with both the price and supply of scrap zinc, copper and lead. In the near future controls would be re-instituted to regulate the prices of scrap and to bring its acquisition under licence.

#### IN THE EDITOR'S POST

##### "Attacking the Tower"

SIR.—While reading your editorial "Attacking the Tower" in your issue of 9 December, I am reminded of a certain factory in the North of England where, it is alleged, people work in an atmosphere of tricresyl phosphate fumes because the Works' Doctor knows that T.C.P. is a good antiseptic.

D. W. LANCASTER.

Surbiton, Surrey.

##### Estimating Moisture

SIR.—I note the comments made by Mr. Voss in your issue of 16 December regarding moisture testing.

I do not think there is any particular difficulty in performing up to 150 tests a day by oven methods, providing that manipulation is reduced to a minimum and that the whole process is really well organised. For efficient work the essentials are a sufficiently large oven to take, say, 50 samples, ample desiccator space, an air damped balance with mechanically operated riders, and counter-poised sample tins. The greatest time in moisture testing is usually taken in weighing samples on and off, but with the above apparatus each weighing need take no more than 30 seconds by a fully experienced operator.

A great deal of time can be saved by having the empty tins placed in the oven over-night, with a time switch to allow them to be properly dried by the time work commences in the morning. The first batch can be quickly weighed on and after that all should proceed smoothly. Subsequent batches can be prepared while the first is in the oven and of course any loss

of moisture after weighing on is immaterial since this moisture would in any case be driven off in the oven. On this system there is ample time to dispose of three batches during the working day.

With regard to the Bravender moisture tester the use of the term spring balance was erroneous as I was working on information I had been given as to a modification of this treatment. I must, however, maintain my assertion that the instrument must be used under standardised conditions if results are to be reproducible, and that variations in time and temperature of drying will lead to irregular results, as in fact is the case with all other oven methods of drying.

I am not in any way decrying the use of the Bravender oven as its easy manipulation makes it a suitable tool for routine moisture estimations, particularly under factory conditions. In my experience, however, weighing in a hot atmosphere is not conducive to accuracy and I would rather see the tins weighed off when cold, particularly as the ordinary analytical balance is usually more accurate than that incorporated in the machine. As I pointed out at the beginning of my paper, however, the criterion of a satisfactory method is really that of suitability, accuracy and reproducibility since with the majority of materials one cannot yet define an obsolete intrinsic moisture figure.

ALAN H. WARD.

Aynesome Laboratories,  
Grange-over-Sands.

##### BIF Takes Shape

CHEMICALS will be among the trade sections which will be having a larger display in London at this year's British Industries Fair, which will be held from 30 April to 11 May. Space allocated to chemicals at Olympia is approximately 24,310 sq. ft., compared with 22,750 sq. ft. in 1950.

Applications for space at Earls Court and Olympia totalled 642,000 sq. ft. compared with 549,634 sq. ft. The biggest demand was from the textile industry for 208,000 sq. ft.—more than three times as much as for the 1950 Fair. In order to keep this large section intact, the whole of the ground floor at Olympia will be devoted to the display of textiles and the printing machinery section will be moved to Olympia.

In the Commonwealth section at Earls Court (10,000 sq. ft.), 20 countries will show their products, resources and ways of life.

## BRITISH ACHIEVEMENTS IN STEEL TECHNOLOGY

**I**N a lecture to the Kring Metalen, of Utrecht, Holland, the application of scientific metallurgy in Great Britain during the past decade was reviewed by N. P. Allen, M.Met., D.Sc. The lecturer discussed one or two interesting developments in each of the major branches and concentrated rather on the properties and applications of metals and alloys than on their production.

When the Ministry of Supply was formed at the outbreak of war they immediately foresaw that there would be shortages of alloying elements, and with the help of the British Iron and Steel Federation they set out to reduce the number of different alloy steels produced and to decide in what circumstances the scarce alloying elements ought to be used. They published a list of "En steels" containing a table, which was the first systematic recognition in specifications of the fact that alloying elements are used in heat treated steels to enable superior properties to be obtained at the centre of large masses.

As the war dragged on and supplies of alloying elements became more difficult to obtain, it came to be stated that the En steels were extravagant in their use of alloys, and it was suggested that steels should be selected with the aid of the Jeminy hardenability test. It was claimed that by the use of this test it was possible to calculate what the hardness would be in the centre of any bar of steel quenched in a sufficiently well defined way; that if the steel had the desired hardness when quenched, it would have the desired mechanical properties when tempered; and that if steels were chosen by the hardenability test alone, great economies of alloying elements would result.

### Calculations Not Accurate

These claims were investigated in very great detail and the data were published in the Iron and Steel Institute "Symposium on the Hardenability of Steel," 1946. It could be concluded (a) that the calculation of the centre hardness cannot be made sufficiently accurate, largely on account of the variations of hardenability across a single bar of steel, but that if a given type of steel is sufficiently well understood, the Jeminy test can be a very useful guide to the effect of limited variations of composition and hardenability; (b) that the behaviour of a quenched and

tempered steel in a tensile test can be reasonably well judged from the results of a Jeminy test but not the behaviour in the Izod impact test. This is important, because the British specifications are based on attaining at a given tensile strength given values of yield point and elongation together with a minimum Izod impact value. It was shown very clearly that it is easy to meet the elongation requirement in an incompletely hardened steel, but not the impact test requirements.

### [Depends on Quality

Opinion on the use of alloying elements depends to a large extent on the standard of quality demanded. There has been a tendency to seek very high values of impact in steels of high tensile strength, and there is no doubt that steels of these properties behave very well when the conditions of service are very severe, but it would be difficult to find convincing evidence to prove that such high impact values are necessary. One effect of this controversy has been to call attention to the importance of knowing exactly what micro-structures can be produced in the different alloy steels by various types of heat treatment. The "S curves" of a full range of British steels have been studied and the information, which has been published in book form (*Atlas of Iso-thermal Transformation Diagrams of B.S. En Steels*, Iron and Steel Institute Special Report No. 40), has proved to be of the greatest value in the heat treatment of large masses of steel.

Hair line cracks were a source of anxiety at one stage of the war. In 1935 Bennek, Schenk and Muller put forward the opinion that they were due essentially to the presence of hydrogen in the steel. This view was far from acceptable to a number of steelmakers in Britain in 1938, but an exhaustive series of experiments was made under the direction of Professor Andrew at Sheffield University over the years 1940 to 1947, and now there are few steelmakers who will not admit that at least hydrogen plays an important part, though many still quite rightly insist that the influence of the microstructure and of the internal stresses originating in the volume changes must not be underestimated. Special heat treatments for removal of the hydrogen have been examined, and it can now be felt that a fairly complete knowledge of the hydro-

gen contents of most ordinary steels is available, and of the way in which the hydrogen content varies during the processing of the steel. It has been demonstrated that the hydrogen escapes most readily just after the steel has transferred from the gamma state to the alpha state on cooling, and for small masses hydrogen removal treatments based on this information are adequate. It has been found, however, that hydrogen never escapes from the centre of really large forgings, though the heat treatments be very prolonged, and these still require to be manufactured with very great care if hair line cracks are to be avoided.

#### Methods Improved

One consequence of this investigation was the improvement of methods for the determination of hydrogen in steel. The investigation provided the opportunity for the methods to be thoroughly examined and extensively practised. The vacuum fusion method and the solid extraction method for determining the hydrogen content of solid steel are now firmly established and it is thought that they can be relied upon to within 0.5 ccs. per 100 gm. of metal. The determination of the hydrogen content of molten metal is less satisfactory. Chilled test pieces of one kind or another are employed, attempts generally being made to collect the gas evolved during solidification, but the reproducibility of the results, as compared with that obtained in determinations on solid specimens, leaves much to be desired. Efforts to improve the methods are still being made.

Another consequence of this work was the development of supersonic methods of detecting the presence of hair line cracks. A convenient apparatus was produced and proved extraordinarily sensitive. In fact, its sensitivity is such that small irregularities of little consequence can sometimes be found, and it becomes a matter of some importance to discover just what variations of structure can be studied with the instrument and what interpretation should be placed upon its indications. Although the supersonic crack detector was developed as a workshop instrument it is being employed extensively as a laboratory tool. There is no doubt that the attenuation of elastic waves within a metal can yield much information about its internal structure. The experiments of Snoek and Dijkistra are now familiar. In Britain similar methods are being used to study grain boundaries and creep in metals, and the whole subject is rousing great interest.

Throughout the decade under discussion,

continuous attempts were made to produce an easily weldable steel of high yield point for general constructional purposes. The mild steel plate supplied for shipbuilding, for example, has a tensile strength of 26-33 tons/sq. in., a yield point of 15-19 tons/sq. in., and is easily welded as a rule. At first attempts were made to raise the yield point to 28 tons/sq. in., and more recently the objective has been to attain a yield point of 30 tons/sq. in.

About 1935, a variety of steels were offered to meet B.S.S. 548 for high tensile steels for structural purposes, but although their yield points were sufficiently high their weldability left much to be desired. The plate tended to crack in the zone next to the weld where the steel had been heated above its critical point, and had hardened. In studying this problem, it soon became evident that cracks were liable to form if the Vickers Diamond Hardness of the heat affected zone of the weld exceeded 350, and that this happened if the "equivalent carbon content" of the steel exceeded a critical value.

Efforts were made to devise a steel having a low "equivalent carbon content" and at the same time a high yield point in the normalised condition. Admiralty "D" steel, which contained about 1.5 per cent of manganese and not more than 0.30 per cent of carbon and had a yield point of 23 tons/sq. in., was widely used, but the conditions under which it could be welded were unduly restricted and "DW" steel, with 0.23 per cent carbon, was substituted at a sacrifice of strength. The yield point of this steel is about 21 tons/sq. in., which was not considered to be sufficiently greater than that of ordinary steel plate, and many attempts to improve it have already been made. The greatest progress has been achieved by reducing the carbon content of the steel and adding molybdenum together with some other element that increases the hardenability of the steel. Molybdenum refines the structure of normalised low carbon steels by suppressing the formation of massive ferrite and pearlite in favour of the acicular products of the intermediate transformation. The changes produce a marked increase of yield point, but provided the carbon content of the steel is low, the acicular products are not brittle, and form so quickly that a fully martensitic structure in the neighbourhood of the weld is not easily produced.

#### Good Weldability

Very good weldability, together with an 0.2 per cent proof stress of about 30 tons/sq. in., was obtained in a steel containing 0.18 per cent of carbon, 2 per cent of

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nickel, and 0.3 per cent of molybdenum. This steel was too expensive for wide use, but very similar properties were obtained with 1½ per cent manganese steel with about the same carbon and molybdenum contents, and, more recently, a steel in which manganese and nickel have both been omitted in favour of boron, has been produced. The carbon content has been still further reduced to below 0.1 per cent and the molybdenum content raised to 0.6 per cent. Although investigations are still proceeding, there is no doubt that weldable steels with yield points of 28-30 tons/sq. in. can be made available if desired.

In Britain plates for ship construction are not made of basic Bessemer steel but of "balanced" basic open hearth steel. The nitrogen content is generally about 0.005 per cent and the question of embrittlement due to nitrogen has not arisen. Catastrophic failures of the kind experienced in the American "Liberty" ships have not occurred with British vessels. Nevertheless, when these failures began to be reported from America it was by no means certain that similar disasters could not happen here, and investigations were set on hand. Their progress is an interesting example of the way in which co-operative research operates. In the first place, a committee of the Admiralty examined a number of plates from various sources, including some which had developed cracks in service, and reported that they all had the property of snapping suddenly in a notched tensile test without great absorption of energy, and with a crystalline fracture when cooled below a certain temperature range, although they tore apart gradually and with a fibrous fracture if tested above that temperature range. The transition range varied widely, being well below 0° C. for some steels and above 100° C. for others, and it was quite uncertain what the behaviour of any steel at normal service temperature would be. The problem was passed to the British Iron and Steel Research Association and a small committee was formed, including representatives of the Admiralty, who examined a series of plates of known history and origin, using a number of different tests.

#### The Association's Conclusions

They concluded (1) that the same property of transition from a tough to a brittle condition is shown in a number of tests of notched bars, which place steels in the same order of quality, although the temperature at which the change occurs varies somewhat in different tests; (2) that thick plates, and plates which have been slowly cooled from above the critical range, have higher transition temperatures than plates

of the same composition that are thinner or have been more quickly cooled; (3) that steels of high manganese and low carbon contents tend to have lower transition temperatures than those with low manganese content and high carbon content.

Acting on the hint provided by the third conclusion, Barr and Honeyman prepared a series of steels having the same tensile strength of 28 tons/sq. in. in the normalised conditions, but with different additions of manganese and carbon. They found that their transition temperatures, both in the normalised and annealed conditions, fell progressively as the ratio of manganese to carbon rose, and it was concluded that it would be a step in the right direction if plate steels were made with a manganese/carbon ratio of not less than 3:1.

#### Recommendation Adopted

This recommendation was adopted, but sufficient had been seen during the course of the work to show that the manganese/carbon ratio was not the only factor to be considered. It was felt that a specification requiring a test of the possession by the steel of the mechanical properties that the engineer thought he needed would be preferable to one in which only certain aspects of the chemical composition were controlled. This situation has been met by asking a committee of engineers representing the users of plate to state the test upon which they are prepared to rely, and arranging for a survey to be made of the behaviour in this test of plate steel made with the suggested manganese/carbon ratio. Meanwhile, it is recognised that we do not know as accurately as we should the factors that control the transition temperature of steel, nor why such factors as the manganese/carbon ratio exert their recognised effects. Arrangements have been made for these matters to be investigated.

#### Jenolite Chemical Sealer

We have been asked to point out that the Jenolite Chemical Sealer is a red oxide primer, which has been especially prepared for application after "Jenolising," particularly when "Jenolite" is used by brushing on, inasmuch as certain ingredients incorporated in the sealer will neutralise any possible acidic residues on the metal surface and utilise these in making an even firmer bond. The sealer dispenses with normal red oxide primers only in so far as it is a red oxide primer itself. The manufacturers (Jenolite, Ltd.) do not recommend lead after "Jenolising."

## THE WRONG KIND OF RESEARCH ?

THE high percentage of all research work being financed by the U.S. Government, particularly the military services and the Atomic Energy Commission, is a potential hazard to the country. Thus proclaimed Professor E. R. Gilliland, 1950 winner of the Celanese Corporation of America professional progress award in chemical engineering, on 5 December in his acceptance address before the annual meeting of the American Institute of Chemical Engineers at Columbus, Ohio.

### Tendency to Channelise

"There are several aspects of this problem that are dangerous," Professor Gilliland said. "First, there is a tendency to channelise research and development work into certain research fields at the expense of others of equal importance. In fact, some of the neglected fields will probably be of more importance in a real emergency than some of those being actively pushed. Second, a considerable portion of it is not research, but is development work."

With the armed services having about \$2000 million a year at their disposal for research and development, or about twice the total for industry and universities, the speaker asserted, the government-sponsored research must involve the effort of a large proportion of the scientists and engineers of the country.

"I seriously question," Professor Gilliland said, "whether the military services have sufficient background in the evolution of modern science and engineering to direct a major part of the research effort of the country even for their own greatest benefit. As a result of serving on several committees and panels of the Research and Development Board of the Defence Department, I am even more concerned about the lack of any real study of the implications of this vast programme.

"We have a major obligation to our country, particularly in its defence and security. However, I am concerned over the fact that one of the main contributions of science and technology is for destructive purposes. I hope that the public does not arrive at the conclusion that the chief contribution of our field is destruction.

"While technically trained people are a necessity in modern warfare, I hope that we can sell the public the view that our main contributions are for the social good and not for destruction. I believe we should make a real effort along this line.

"It is frequently said that science and technology are neutral and that the harmful effects are only in the way they are applied. I do not agree with this philo-

sophy. To a considerable degree the different phases of technological endeavour can be differentiated as to those that are likely to make sociological improvements and those that would have their major effect along military lines.

"It is not possible to foresee the whole outcome of any technical development, but with our understanding of human nature, developments that lead to improved living conditions, such as better housing, better medicine, better nutrition, are much more likely to be important sociologically than is the development of long-range rockets.

"While it is difficult to refuse money for any intriguing programme, in a great many instances it is possible for us to make decisions relative to the research we are conducting. We should concentrate our efforts along those lines which we believe will be most beneficial.

"It is not enough for us to take a neutral position relative to science and engineering and put the blame on others. We must take the initiative and consider the implications of the work we are doing."

### Bowmans Chemicals

THE effect of the world shortage of sulphur is referred to in the chairman's statement to be presented to shareholders by Mr. S. H. W. Pert at the 45th annual general meeting of Bowmans Chemicals, Ltd., to be held at Widnes, on 9 January.

Sulphuric acid is the main raw material in the manufacture of most of the company's products, and although the position for some items has improved, this shortage will reduce the export trade of its main product, lactic acid.

Tribute to the work of Mr. G. E. Guest, who retired from the chairmanship in March last is also made in the statement.

Net profit for the year is £7811 and a final dividend of 7½ per cent on ordinary shares, making with the interim dividend paid on 15 July, a total of 10 per cent, less income tax.

### Southern Rhodesia Beryl

Beryl, a mineral which was first mined in Southern Rhodesia a little more than a year ago, is rapidly becoming one of the Colony's most sought after minerals as a result of its use in atomic production. This was stated in a report issued by the Office of the High Commissioner for S. Rhodesia. For the first ten months of 1950, beryllium production was valued at almost £50,000; beryllium ore sells at £80 a ton. Mining experts aver that considerable quantities still remain to be identified.

## CANADA'S METALS AND MINERALS

### Developments in 1948 Reviewed

**R**AW material shortages which are now causing considerable concern throughout the world lend particular interest to the reports on "The Canadian Mineral Industry in 1948" now published by the Mines Branch of the Department of Mines and Technical Surveys, Canada.

Information on activities relating to the metals and minerals produced in the Dominion reveals changes of great significance. Recent developments in the West that show promise of eventually making Canada self-sufficient in crude oil afford an outstanding illustration, as do those in the Quebec-Labrador region where large deposits of iron ore are being prepared for production, and in the Allard Lake area, Quebec, where work is proceeding towards bringing large deposits of titanium ore into production.

The survey is divided into two sections, metals, and industrial minerals from which the following facts are abstracted:—

All pyrites produced in Canada is obtained as a by-product from the concentration of base metal sulphide ores, and none is mined as a primary material. The sulphur content of these pyrites concentrates ranges from 47 to 50 per cent. Pyrites in this form is sold for making sulphuric acid at plants in British Columbia, Ontario, and Quebec, and is exported to the United States and Mexico for the same purpose.

Smelter gases constitute the principal source of sulphuric acid.

#### Native Sulphur Unknown

Native sulphur is not known to occur in commercial quantities in Canada but it has been produced from smelter gases at Trail, British Columbia, by Consolidated Smelters. It is not being produced at present because all the sulphur in the gases is required for making sulphuric acid for use in the manufacture of fertilisers.

Noranda Mines, Ltd., has large-scale experimental work under way on the production of sulphur and iron from pyrites. If a commercial process is evolved there is sufficient pyrites available in the Noranda district to produce 200,000 tons of sulphur annually for many years.

The deposits of anhydrite and gypsum in the Maritime Provinces and elsewhere in Canada constitute a huge potential source of sulphur and its compounds.

A process producing sulphuric acid and

Portland cement from anhydrite and gypsum is in successful operation in Germany, England, and France. Atlantic Chemicals, Ltd., a newly formed company, proposes to employ this process at Hillsborough, New Brunswick, but plant construction is not yet under way.

#### Salt Industry Expanded

The Canadian salt industry provided further tangible evidence of expansion in 1948. The new salt plant of Alberta Salt Co., Ltd., Lindbergh, Alberta, was brought into production early in the year; construction in Sarnia, Ontario, of the caustic soda-chlorine plant of Dow Chemical Company of Canada, Ltd., was nearing completion; and construction was commenced in Beauharnois, Quebec, of a similar plant by Dominion Alkali and Chemical Co., Ltd. (subsidiary of Dominion Tar and Chemical Co., Ltd.). The output of 741,261 short tons of salt in 1948 was slightly higher than in 1947, the previous peak year. Ontario produced 84 per cent of the total output.

The salt produced in the Dominion is chiefly in the form of fine grades from brine and vacuum pan operations.

Lime is one of the great basic raw materials of the modern chemical and metallurgical industries. Large quantities are also used in the construction industry. Hydrated lime is used in agriculture as the principal ingredient of certain spray mixtures and dusting powders and for sweetening acid farmland.

The exceptionally strong demand for the product was reflected in the record output in 1948 of 1,053,584 tons valued at \$10,655,062.

Production of fluorspar rose to 11,340 tons, an increase of 58 per cent over 1947. Due to lack of reserves, however, Canada continued to depend largely on imports to meet domestic requirements.

Fluorspar is used chiefly as a powerful fluxing agent in open-hearth steel furnaces and in smaller amounts in numerous other metallurgical industries. The next largest market is for the manufacture of hydrofluoric acid for use in the aluminium industry. Most of the fluorspar imported into Canada from Newfoundland is used for this purpose at Arvida, Quebec. The ceramic industry ranks third, using it as a fluxing and opacifying ingredient in glass and enamels. Uranium hexafluoride is used

for the gaseous diffusion separation of the uranium isotopes  $U_{235}$  and  $U_{238}$  in the development of atomic energy.

Aluminium production in Canada during 1948 was 367,079 tons—the third greatest production on record, and would have been still greater had not an unprecedented shortage of water for power-generating purposes in the latter part of the year necessitated closing some of the pot lines.

World demand for chromite eased during the year and there were no new developments of consequence in relation to Canadian production.

The cobalt content of Canadian ores, concentrates, oxides, metals and salts of the metal shipped in 1948 amounted to 772 tons compared with 286 tons in the previous year.

### Increased Lead Production

Canada's lead production (exclusive of Newfoundland) was 167,251 tons, of which 96 per cent was refined. This total showed a slight increase over 1947, and the value reached a peak of \$60,344,146. The price rose during the year from 14.25 to 20.5 cents per lb. Several noteworthy discoveries of lead-bearing ores were reported.

Plans were made during the year for the establishment of a substantial titanium industry in Canada, based upon development of the large deposit of ilmenite at Allard Lake, Quebec. Discovered in 1946 by the prospectors of Kennecott Explorations, a subsidiary of Kennecott Copper Corporation, this deposit has been tested by drilling and is known to contain upwards of 150 million tons of ore averaging 35 per cent  $TiO_2$  and 40 per cent iron.

Production of refined zinc and of zinc contained in concentrates consigned for exports was higher in 1948 than in the previous year, and a record output value was set for the second successive year. The price of high-grade zinc in Canada increased during the year from 11 to 18 cents per lb.

### NEW SYNTHETIC FIBRE

**D**YNEL, a new synthetic fibre, the result of eight years' research work, was formally introduced by the textile fibres department, carbide and carbon chemicals division of the Union Carbide and Carbon Corporation at a recent Press view in New York.

The new fibre, which is a copolymer of vinyl chloride (60 per cent) and acrylonitrile (40 per cent) has already been in use for industrial applications, such as filter cloths, but will be available to consumers

in a wide variety of products from the early part of this year.

Commercial production began in July last, and the plant at South Charleston, West Virginia, is now operating at the rate of several million lb. annually.

Dynel marks Union Carbide's active entry into the field of staple fibre production. The product is claimed to be one of the most economical of the true synthetic fibres and its price of \$1.25 per lb. of staple and tow compares favourably with the price of clean, scoured wool. The new synthetic is also priced lower than others Fibre V, Orlon and Nylon which currently sell for about \$1.75 per lb.

Characteristics of Dynel of major interest to the consumer are sensitivity to heat, resilience, warmth, dimensional stability, rapid drying, good strength—dry and wet-resistance to combustion (it cannot be ignited), mildew-proofness, mothproofness, and high chemical resistance.

An example of the product's chemical resistance is cited in its use for uniforms in chemical works. Dynel clothing is said to have a life of four to five months longer than uniforms previously used. In one plant where garments were badly stained by catalysts, Dynel uniforms were regularly washed in sulphuric acid, the only remover for the stain, with no damage to the fabric.

Filter cloth made of the new synthetic has proved especially valuable in dyestuff and pigment filtration, especially where high acidity is present.

### Dust Fume Bags in Use

Dust fume bags made from dynel-wool blends are now being used and can be placed in stack atmospheres at temperatures of  $300^{\circ}$  to  $350^{\circ}$ F.

Demand for this new fibre is said to be such that even the maximum present output can only meet about 25 per cent of the requirements. If the textile industry and consumers approve of it, Union Carbide is prepared to make a substantial investment in new production facilities.

Although in the early stages of development the dyeing of Dynel presented a number of problems, these have now been overcome by new techniques and practically all shades are obtainable through the use of acetate and direct dyestuffs. In comparison with Du Pont's Orlon and Chemstrand's as yet unnamed new synthetic fibre, Dynel is said to be superior with respect to resistance to combustion, chemical resistance, dyeability and economy. It is not, however, nearly so weather resistant as Orlon, while the heat resistance of both Orlon and Chemstrand is superior to Dynel.

## PRODUCTION GAINS IN GERMANY

### Coal and Power Shortages Upset Output Plans

**A**CUTE difficulties have been caused in the heavy chemicals industry of Western Germany by the shortage of coal. The production of Roechling phosphate had to be discontinued early in December, ground and granulated cyanamide is sold out until the end of January, and potash salts are obtainable only in paper bags or loose as hessians are not available. Nitrogenous fertilisers and most industrial chemicals were still in adequate supply before Christmas, though the shortage of coal was creating difficulties in some regions.

How greatly the German chemical industry has been helped by the autumn boom after the rather disappointing spring and early summer is shown by a comparison of production figures for October with the monthly average for the first quarter of the past year (in metric tons): Sulphuric acid 109,000 (86,600), soda ( $\text{Na}_2\text{CO}_3$ ) 75,200 (51,200), chlorine 20,700 (16,300), caustic soda and lye 30,600 (24,800), calcium carbide 47,300 (27,600), ethylene oxide 2300 (1600), acetic acid 5600 (3900), acetaldehyde 11,400 (8000), coal-tar oils 31,900 (28,000), polyvinyl chloride 1700 (780), polyvinyl acetate 1250 (800), organic dyestuffs 3280 (2080), mineral pigments 24,500 (16,200), lacquers and varnishes etc., 18,100 (12,200).

#### Satisfaction the Keynote

Satisfaction with the progress achieved this year is the keynote of most of the company reports published recently. Chemische Werke Albert AG have greatly increased their sales since the middle of 1950; exports account for about 10 per cent of the total. DM 1,300,000—compared with fixed assets of DM 14,480,000 in the balance-sheet for the end of 1949—were spent on urgent investments in January–October last. Vereinigte Ultramarinfabriken AG notes a substantial improvement, especially in exports, with the result that the works are fully employed and long delivery terms must be stipulated for some new orders; a further extension of the plant has become necessary. Chemische Werke Brockhues AG complains about unsteady conditions in the business year ended September, but nevertheless raised its sales abroad. Hageda AG records a considerable increase in the sales of pharmaceutical preparations.

Braunkohle-Benzin AG (Brabag), the large combine responsible for the erection and operation of the large lignite hydro-

genation and synthesis plants at Zeitz, Bochlen, Magdeburg and Schwarzeide before and during the war has found a new field of activity in the West German oil refining industry. Together with the Stinnes coal and steel group, it has formed Ruhrbau GmbH for the erection of a new oil refinery with an initial capacity of 100,000 tons. Installations of the shale oil processing plant at Balingen, Württemberg, will be used in the new refinery which is later to be doubled; topping and cracking plant is also to be installed. The cracking capacity of the Deurag oil refinery at Misburg has been increased from originally 145,000 to 270,000 tons.

#### Production Plans Upset

Although Allied permission was obtained for resumption of operations in the Lippewerk aluminium plant at Luenen, the shortage of electric power upset the production plans. The plant began operations on 6 December at a monthly rate of 600 tons, instead of 100 tons as projected. Meanwhile it has been announced that negotiations are in progress with the ECA Mission for Western Germany for a loan of DM 34 million out of ERP counterpart funds for the German aluminium works. The Federal Republic is to receive about 450,000 of Greek bauxite in the next three or four years, and the U.S. Government intends to buy approximately 17,000 tons of aluminium in this period from Western Germany from the U.S. stockpile. Dismantling has been suspended at the aluminium work of Toeing, and according to U.S. circles in Germany, dismantling operations at this plant also hope for a substantial easing, if not the complete abolition, of the restrictions on aluminium production in Western Germany.

A West German trade agreement with Pakistan has come into force with retrospective effect from 1 October. By the end of 1951 Western Germany is to supply Pakistan with \$2,700,000 worth of industrial chemicals and fertilisers, \$1,570,000 of drugs, pharmaceutical preparations, dyestuffs and tanning agents, and \$5,020,000 of paints and lacquers. Unexpected difficulties are being experienced by German chemical exporters in trade with some European countries. Spain and Hungary have fallen in arrears with the delivery of agricultural produce to Germany and run up large deficits, while exports to Czechoslovakia are subject to strict supervision by the U.S. authorities in Germany.

# INCREASED FERTILISER CONSUMPTION

## Effects of Subsidy Removal

**N**EW records both in production and consumption of nitrogen fertilisers were attained in the year ending 30 June 1950, according to the 30th annual report of the British Sulphate of Ammonia Federation, Ltd., now published. The past year was the 53rd year of propaganda work undertaken successively by the Sulphate of Ammonia Committee, the association, the federation, Nitram, Ltd., and I.C.I., Ltd.

### Production Exceeded Consumption

Although world consumption of nitrogen fertiliser estimated at 8.79 million metric tons was greater than in the previous year, production also increased and again exceeded consumption. As a result, producers and distributors now have an adequate working stock for the first time for many years.

Exceptionally large deliveries were made to farmers during May and June. This demand was due partly to weather conditions but was also influenced by the knowledge that a substantial increase in price would take place on 1 July 1950 owing to the removal of about half the subsidy on fertilisers.

It is estimated that about 20,000 tons of nitrogen may have been carried forward to the coming year. On this basis the increase in home consumption of fertiliser nitrogen in 1949/50 was about 11 per cent.

This substantial increase in consumption is undoubtedly due to the fact that more and more farmers are now beginning to appreciate that adequate use of suitable fertilisers at the right time is essential for the improvement of yield and quality of crops.

### Record Demand For Compounds

The weather throughout the year was generally favourable for the use of fertilisers and the record demand for compound types containing sulphate of ammonia as the nitrogen ingredient showed that farmers recognised the importance of a proper balance of plant nutrients. Despite this increase in the use of compounds the demand for sulphate of ammonia for direct application was only slightly less than for the previous year.

Silage making is expanding satisfac-

tory and is gradually becoming established as a standard method of fodder conservation by an increasing number of farmers. Additional grass dryers operated on a co-operative or contractual basis came into production during the year.

Both methods have received considerable stimulus as a result of the final removal of subsidies on feeding-stuffs and farmers are becoming more receptive of advice to improve grassland management and grazing technique with the object of reducing the cost of feeding stock. Improvements along these lines must result in an increased demand for nitrogen.

In 1945 I.C.I. Ltd. laid plans for the development of grassland as a large new market for sulphate of ammonia and began collecting data by accurate measurement on a farm scale in a number of counties. The information thus obtained is now becoming available for the purpose of propaganda and demonstration.

### Demonstrations Planned

While full use continues to be made of advertisement and educational literature greater emphasis can now be put on demonstrations at farms of methods for obtaining early grazing and for controlling grazing. Arrangements are now in hand to provide at least two farm demonstration centres in every county by 1952.

The meetings between the research department staff and the technical representatives of members continued to be well attended. Steady progress was made in the production of salt of improved quality and during the year 86 per cent of the total by-product salt made was of Grade 1 standard.

Resin cements and lacquers have been successfully used on an increasing scale for the protection of surfaces liable to suffer from erosion.

Exports during 1949/50 were 15 per cent greater than in 1948/49. During the six years ending 30 June 1949, export tonnages were allocated by the Board of Trade in collaboration with various international committees. International control ceased at that date but the Board of Trade continues to control the allocation of all forms of nitrogenous fertilisers exported from the United Kingdom.

## THE DETERMINATION OF ZINC

*At the third meeting of the Midlands Analytical Methods' Discussion Group held recently in Birmingham, the subject—"The Determination of Zinc"—was introduced by Mr. G. W. C. Milner, Bragg Laboratory, Admiralty, Sheffield, and Mr. B. H. Coss-ham, Imperial Smelting Corporation Ltd., Avonmouth. The following is a summary of what was said:—*

**T**HE estimation of zinc is one of the most important of industrial analyses. The methods used at the present time for the determination of zinc may be classified as follows:

1. Gravimetric.
2. Volumetric.
3. Absorptiometric.
4. Polarographic.

Although gravimetric methods for the estimation of zinc are time-consuming, nevertheless, their use is justified to a certain extent by the accuracy of the results obtained. In most zinc analyses it is essential that the heavy metals present be removed before the final estimation of zinc is carried out. Group I and Group II metals are removed in the normal way by precipitation as chlorides and sulphides respectively. It is then possible to separate zinc from the remaining elements by precipitation as zinc sulphide from a formic acid solution containing tartaric acid. The general procedure is to boil the acid filtrate from the Group II precipitation until free from  $H_2S$  and until the volume is about 200 ml. Sufficient 30 per cent tartaric acid is then added to complex any metals of Group III which may be present, and the solution is neutralised with ammonia using methyl red as indicator. A 20 per cent aqueous solution of formic acid containing 3 per cent of ammonia and 25 per cent of ammonium sulphate is added, the mixture heated to 80°C., and  $H_2S$  passed in until a white precipitate of zinc sulphide appears. Paper pulp is added to aid coagulation of the precipitate and  $H_2S$  passed for a further 30 minutes. The precipitate is then filtered on a pulp pad and washed with a weak formic acid— $H_2S$  solution.

### Several Objections

The determination may be completed by ignition of the precipitate to the oxide, but there are several objections to this procedure: Thus

(I) Any zinc sulphate formed during the ignition of the precipitate is not decomposed until a temperature 950°C. is reached, while the oxide itself volatilises at about 1000°C.

(II) Zinc is lost at low temperatures if the ignition is too rapid and if carbon from the ignited filter paper is present.

(III) Ignited zinc oxide is hygroscopic, and cooling over a powerful desiccant is essential.

In view of these disadvantages, some workers prefer to dissolve the zinc sulphide precipitate in acid and reprecipitate the zinc as zinc mercuric thiocyanate. The procedure is lengthy and may be summarised:

### Summary of Procedure

The zinc sulphide precipitate is dissolved in 1:1 hydrochloric acid, a few mls. of 1:1 sulphuric acid added, and the solution evaporated to fumes. The residue is dissolved in water (if organic matter is present, e.g. from filter paper, nitric acid is added and the whole refumed) and the zinc precipitated with potassium mercuric thiocyanate. The mixture is allowed to stand for several hours, preferably overnight, to ensure complete precipitation of the zinc. The precipitate is then filtered through a sintered glass crucible, washed with a dilute solution of the reagent, and dried at 105°C. A very favourable conversion factor for the zinc is obtained, and the method gives excellent results. However, the long standing time and the necessity for complete separation of zinc from most other heavy metals renders the method unattractive, more especially in industrial laboratories, where more rapid, though equally accurate, methods are required.

Precipitate of the zinc may also be effected with 8-hydroxyquinoline over a wide pH range. The complex zinc oxinate may be determined gravimetrically, or dissolved in acid and titrated bromometrically. In both cases, a good conversion factor for zinc is obtained. Unfortunately, in certain alloy analyses it is difficult to obtain the correct conditions for the complete selective precipitation of the zinc. For example, in the analysis of tin bronze, the zinc oxinate is precipitated from strong alkaline solution containing cyanide to complex the copper, and sodium potassium tartrate to complex tin, lead, etc. The method works very well for alloys containing more than 2 per cent of zinc, but is unreliable if less than this amount is present. Consequently, for inspection analyses, certain modifications are necessary.

### Volumetric Methods

The well known zinc-ferrocyanide titration depends on the fact that if ferrocyanide ions are removed (as insoluble zinc ferrocyanide) from a solution containing ferrocyanide and ferricyanide, an increase in oxidation potential of the system occurs. Certain organic compounds give coloured oxidation products under these conditions and several such compounds have been recommended as internal indicators for the titration; for example, diphenylamine and diphenylbenzidine (Cone and Cady), p-ethoxychrysoidine (Tyler) and o-dianisidine (Frost).

Recently, Belcher and Nutten have proposed naphthidine as an internal indicator for the titration and prefer it to o-dianisidine, as it gives a better colour change at the end-point (white → pink). They use a back titration procedure at room temperature, because, in the direct titration or back titration at elevated temperatures, low results are obtained. More recently, Stephen, in collaboration with these workers, has developed 8,8'-dimethylnaphthidine as an internal indicator for the titration. It possesses several advantages over naphthidine; thus, it is more sensitive, gives a better end-point colour (white → red-violet), and may be used with N/1000 zinc or ferrocyanide solutions. It is not yet, however, commercially available as is its homologue naphthidine.

### External Indicator

Several workers prefer the older external indicator procedure, because the internal indicators often will not function or yield anomalous results under the particular conditions obtaining in their solutions. Cadmium may be titrated directly with ferrocyanide using an external indicator, but no end-point can be obtained using the available internal indicators under the normal titration conditions.

There is no information as to whether the new indicators will function in the presence of organic material, though one worker reports that there is no interference when the titration is carried out in the presence of the trifluoracetate ion.

Potentiometric methods also give low results when a direct titration procedure is employed, while a stoichiometric relationship is obtained using a back titration procedure.

Mention may be made of the work of Nimer, Haum, and Lee, who showed that zinc can be titrated stoichiometrically with ferrocyanide in ammonium acetate solution using an amperometric method. The composition of the precipitate formed during the titration approaches very

closely to that of the single salt Zn<sub>2</sub>Fe(CN)<sub>6</sub>.

In titrations where mineral acid is present, a double salt is formed, but there is no doubt that further work on the stoichiometry of the zinc-ferrocyanide reaction is required.

### Absorptiometric Methods

The best colour reagent for zinc is dithizone. It is of particular value for the determination of trace amounts of zinc in alloys, and has been recommended by the British Aluminium Co., for the determination of up to 0.03 per cent of zinc in aluminium alloys. Briefly the procedure employed is as follows: The alloy is dissolved in acid and the pH of the solution adjusted to 6.9. The zinc is completely extracted by shaking with a 0.01 per cent solution of dithizone in carbon tetrachloride, and transferred to the aqueous layer by shaking with N/50 hydrochloric acid. Sodium thiosulphate and an acetate buffer are then added, and the mixture shaken with 0.002 per cent dithizone solution. The organic layer is "Spekked" and the zinc content determined by reference to a calibration graph.

### Polarographic Methods

Zinc gives excellent steps from many base electrolytes and, hence, this technique is ideal for its determination. Alkaline base electrolytes have proved most satisfactory in routine analytical work, because dissolved air can easily be removed by the addition of sodium sulphite. Ammoniacal solutions have found a wider application than the caustic alkalis in this respect.

An excellent zinc wave preceded by a nickel wave may be obtained in a base of composition 0.2 M ammonium chloride, 1 M ammonia, 0.1 M sodium sulphite, the solution being 0.005 per cent with respect to gelatine. In the presence of lead, a mixed ammonium sulphate and ammonium carbonate base will precipitate the lead and give well-separated nickel and zinc steps.

For the determination of zinc in brass (which generally contains some nickel) it is advisable to separate the two elements. This is best achieved by precipitation of zinc as sulphide from an alkaline cyanide solution of the alloy by boiling with a sodium polysulphide mixture. The precipitate is filtered, dissolved in hydrochloric acid, made just ammoniacal and "polarographed" over the range -0.8v. to -1.5v.

For the determination of zinc in aluminium alloys, Stross uses a sodium hydroxide base solution. The reduction of zincate ions in 1 N sodium hydroxide containing 0.01 per cent of gelatine gives a fairly well-defined step ( $E_1 = -1.53v.$ ) but a better defined step is obtained with N/10 sodium hydroxide ( $E_2 = -1.42v.$ ).

# CHEMICAL ENGINEERS' EXAMINATION

## Improvement in General Standard

**I**MPROVED technical standards were noted in the report of the board of examiners for the associate membership examination, 1950, of the Institution of Chemical Engineers. No outstandingly good set of answers was submitted, however, and it was therefore decided that no award would be made of the William Macnab Medal in respect of this examination.

The quality of the drawings still left much room for improvement. Handwriting was often bad, mistakes in spelling and grammar were frequent and, even in "considered" essays, the style and method of presentation were, in a number of cases, poor.

There was an entry of 118 candidates for the examination, which was the 25th of the series. Successful candidates numbered 77 (that is 65 per cent), a marked increase over 1949, when only 61 out of 115 candidates (53 per cent) satisfied the examiners.

Results showed that 32 out of 58 passed the full examination; 35 out of 48 passed in sections A and B; and 10 out of 17 passed in various papers in which they had been previously referred.

The Home paper consisted of sections A and B, in each of which candidates were required to answer one question out of four.

In section A this year saw the introduction of a recommendation that answers should not, as a rule, exceed 20,000 words. In consequence, verbiage and extensive quotation from the literature were reduced and detailed treatment of minor features was avoided. The chief weakness was a lack of practical experience, which showed itself in over-elaborate design or in the design of units difficult to fabricate. Answers were, on the whole, well presented in this paper, although some candidates seemed to consider (wrongly) that an index to sections of the answer dispensed with the need for a descriptive summary.

### Immature Style

The paper in section B on this occasion consisted entirely of questions of the essay type. Many of the answers suffered from immaturity of style and too much quotation from published work, sometimes without acknowledgement.

The written papers consisted of sections C, D and E. Each of these was divided into two parts of five questions, and can-

dicates were required to answer two from each part. Paper F was an exercise in engineering drawing.

Section C was devoted largely to the fundamental principles of heat transmission and fluid flow. Part 1 consisted of questions each of which involved calculation. It was noticeable that question 1 on metering a fluctuating oil flow, question 2 on steam expansion in a turbo-generator, and question 3 on the yield from a catalytic process, were not popular, since over 80 per cent of the candidates chose questions 4 and 5. Question 4, on the design of a gas heater was answered fairly well, the principal faults being a misunderstanding of the term "mass velocity" and arithmetical errors in placing the decimal point. Answers to question 5 on the surface temperature of a lagged steam pipe were also generally satisfactory but for the unnecessary use of the logarithmic mean for small variations in the temperature difference.

### Problems Avoided

In part 2, question 6, on the accurate control of flow for a given purpose, and question 10, centrifugal pumps, were generally ignored. The calculations in question 7 on the design of a condenser were well done but the sketches of the equipment showed a lack of practical sense. Question 8, dealing with the conveyance of materials was well answered and, in question 9, the theoretical treatment and descriptive matter regarding separation of solids by sedimentation were generally good, but few candidates gave the correct solution to the calculation.

Chemical engineering processes were dealt with in section D, and the questions were very unevenly answered. The calculations in questions 1 on water cooling towers and 2 on pressure drop through a contact mass were badly done, and there were many arithmetical errors, again including the misplacement of the decimal point. Questions 3 revealed a lack of knowledge of the method of plotting a curve for rate of drying, and in question 4 a similar lack of knowledge was shown of relationships used in filter press calculations. Question 5 on leaching was generally avoided.

In the second part, question 6, on molecular distillation, and question 8, on electrostatic precipitation, were popular and generally well answered. Question 7, on

(continued at foot of next page)

## THE NEW YEAR HONOURS

### Scientific Services Rewarded

**A**MONG the Knights Bachelor designated in the New Year Honours List this week were: DR. CHRISTOPHER HINTON, M.I.C.E., M.I.Mech.E., deputy controller of Atomic Energy (Production) Ministry of Supply, who was responsible for the large atomic research plant at Sellafield, in Cumberland and COLONEL VICTOR DUNN WARREN, M.B.E., T.D., A.M.I.Min.E., Lord Provost of Glasgow, who is regional manager for Scotland and Ireland of I.C.I. Ltd.

Other honours conferred included the following:—

**C.B.:** E. BARNARD, deputy secretary, Department of Scientific and Industrial Research; W. R. J. COOK, chief of the Royal Naval Scientific Service; W. F. P. MCCLINTOCK, lately director of the Geological Survey and Museum.

**K.B.E.:** HARRY MASON GARNER, Chief Scientist, Ministry of Supply; A. E. TRUEMAN, chairman, University Grants Committee.

**C.B.E.:** S. E. CHISHOLM, assistant comptroller, Patent Office; H. CONSTANT,

director, National Gas Turbine Establishment, Ministry of Supply; A. H. R. GOLDIE, deputy director (Research) Meteorological Office, Air Ministry; J. C. JONES, director of education, the Polytechnic, Regent Street, London; W. L. M. O'CONNOR, director of carbonisation, National Coal Board; V. B. WIGGLEWORTH, director, unit of insect physiology, Agricultural Research Council.

**O.B.E.:** W. L. DAY, Eng.I., Atomic Energy Establishment, Ministry of Supply; E. A. LOVELL, principal scientific officer, Air Ministry; W. HUME-ROTHERY, lecturer in metallurgical chemistry, Oxford University.

**M.B.E.:** H. V. POLLARD, senior executive officer, Department of Scientific and Industrial Research; L. RUSHFORTH, Research Laboratory, British Thomson-Houston, Ltd., Rugby; A. GRIDLEY, senior artificer, Department of Scientific and Industrial Research; J. T. HATHAWAY, rolling mill foreman, Henry Wiggin & Co., Ltd.; Miss E. MIDDLETON, machine operator, I.C.I. Ltd., Birmingham.

#### CHEMICAL [ENGINEERS'] EXAM.

*continued from previous page*

the operation of packed columns, was attempted by two candidates only; in each case the answer was unsatisfactory. The answers to question 9, on crystallisation, were very poor and showed ignorance of Mier's theory and the supersolubility curve, while in question 10 very few candidates appeared to know how to reduce a mixture of sizes to an average size.

Materials of construction, steam and power generation and utilisation, and factory lay-out and construction generally, were dealt with in section E.

In part 1, the compulsory question, No. 1, on materials of construction for specific operations, was well answered. Question 2, a calculation for a surface condenser, was popular and the answers were satisfactory. Very few candidates attempted questions 3 on the Mollier diagram and 4, on heat cycles, indicating a general reluctance to tackle problems in thermodynamics. The satisfactory answers to question 5 on producer gas combustion were marred in some instances by ignorance of the fact that fuel gas analyses are given on a dry basis.

A second compulsory question in part 2,

No. 6, was introduced for the first time. This was a test of knowledge of fundamental mathematical principles and their application. The answers were poor; it can only be concluded that many candidates do not understand these fundamental principles and take "standard" questions for granted. The large number of incorrect attempts at part (d) of this question, dealing with fluid flow, was particularly disappointing. Question 7, on corrosion, and question 8, on the working pressure of a cylindrical vessel were not popular.

#### Poor Drawings

The drawings in paper F were generally of a low standard, which has been the case in many previous years. Some five per cent of the answers were valueless, showing a complete lack of experience in either reading or making a drawing. It should be emphasised that the first stage in design for the chemical engineer, namely, the calculation of heat quantities, pressure drops, and so on, must be followed by translation into engineering practice. These two stages cannot be entirely separated and this translation is facilitated when the chemical engineer is able to make neat and workmanlike drawings.

## ACID COLORIMETRIC TEST FOR METALS

**A**METHOD for rapidly determining qualitatively and semi-quantitatively metallic elements in steels or light alloys by action of a drop or two of suitable acid and the colorimetric effect thereof has been described by P. Reboul of the Creusot Works laboratories. The method is said to be applicable for detection of Ni, Co, Mo, Cr, V, W, Mn, Cu, Zn, Pb, Sn. It is simple, rapid, and can be used in the works without elaborate equipment. (*Chim. et Ind.*, 1950, 64 (5), pp. 574-579, November.)

The reagents used should have the following properties: (a) produce characteristic chemical phenomena—precipitation, colour effects, crystallisation; (b) be extremely sensitive since the amount of test material affected must be insignificant; (c) be specific, i.e., related to the presence of a single element. The first is fairly common in the usual methods of metallurgical analysis; the second is much less so and requires complicated procedure and special agents; while the third is hardly ever realised. Some of the basic factors and methods involved in drop analysis are indicated, with particular reference to specificity and sensitivity; also necessary precautions to be observed in applying the acidic reagent to the metal. This latter must be perfectly clean and free from oxide; action must take place in the cold; special care used in applying the drop of agent and in removing same with attacked metal in solution; the serial order of reagents added must be scrupulously followed.

**Nickel:** For nickel content above 0.2 per cent the principal reagents are nitric acid or aqua regia for acid attack (etching), and dimethylglyoxime and sodium acetate solutions for colorimetric test, yielding a red ppt. more or less abundant according to the Ni content. Principal disturbing factor is cobalt, but it is shown later how to deal with this. For contents below 0.2 per cent Ni aqua regia is used for attack, with ammonium fluoride in place of sodium acetate, together with dimethylglyoxime and hydrogen peroxide. For nickel content in cobalt steels etching is done with aqua regia and resulting solution treated with mixture ammonium persulphate, tartaric acid, sodium acetate, and dimethylglyoxime. For Ni contents above 0.2 per cent about ten samples can be tested at once, and take about ten minutes.

**Cobalt:** The detector is  $\alpha$ -nitroso- $\beta$ -naphthol which gives with Co a wine-red

precipitate. Other reagents are ammonium fluoride, hydrogen peroxide, acetic acid, with aqua regia for etching. Ten tests can be made simultaneously in 15-20 minutes. The use of hydrogen peroxide and ammonium fluoride prevent interference by ferric or ferrous iron.

**Molybdenum:** The detector is potassium ethyl-xanthogenate, with aqua regia for etching. This latter should not be left to react too long or completely, otherwise the solution will contain too much iron. The other principal reagent is perchloric acid. The method can be used for Mo contents between 0.1 and 5 per cent; and time required for three tests at once is 2-3 min. Colour is more or less deep violet.

**Chromium:** The detector is diphenylcarbazide, with aqua regia for etching. The method is somewhat more complicated as the chromium must first be converted to bichromic acid ( $\text{anion } \text{CrO}_4^{2-}$ ) in order to react definitely with the detector. Other reagents are solutions of soda, permanganate of potash, sulphuric acid, also 95° alcohol. Colour is carmine red.

A more simple and rapid method is described if it is merely a matter of distinguishing low chromium steels (<2 per cent) from high chromium steels (e.g., stainless with >10 per cent).

**Tungsten:** Detector rhodamine B, etching with sulphuric plus nitric acid and ammonium fluoride, etched surface being defined with a little paraffin. Other reagents for use with detector are sodium acetate and hydrochloric acid. Yellowish-red colour of original rhodamine B gradually turns to violet more or less intense. It may be remarked that perchloric acid also gives deep violet colour with rhodamine.

**Copper:** Detector dimethylaminobenzylidenerhodamine producing a rose colour. The reagent mixture consists of ammonium fluoride, sulphuric acid and detector; with aqua regia for etching.

**Titanium:** Detector may be hydroquinone, or paradiphenol, producing a violet tint with Ti, with aqua regia for etching. Other reagents used with detector are sulpho-phosphoric and stannous chloride solutions.

**Zinc:** Detector ammonium mercurithiocyanate giving deep violet ppt.

**Tin:** Detector silver nitrate giving black deposit and white ppt.

**Lead:** No special organic detector. Mixture used consists of HCl, sodium acetate and potassium chromate solutions.

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# Metallurgical Section

6 January 1951

## PURE METALS BY AMALGAM PROCESS

### Recent Work in Germany

**C**ONSIDERABLE information has been given recently on the development of amalgam chemistry and metallurgy in Germany, especially in connection with the chlorine and alkali industries, in which the amalgam cell has for some time been widely used. Its application to metal separation and refining was a somewhat later extension. An informative paper on the subject was contributed by R. B. MacMullin in a symposium at the Houston meeting this year of the Am. Inst. Chem. Engr. (*Chem. Engr. Prog.*, September, 1950). At the end of his paper MacMullin added some notes on the work undertaken by the Duisberg Copper Co. in the recovery of metal values from pyrite cinders collected from German and foreign sulphuric acid plants—already dealt with in several FIAT reports.

The cinders are crushed and roasted with sodium chloride at 1100-1200° C. The metal values indeed cover a remarkably wide range, even if some are no more than traces, namely: Zn, Na, Mg, Al, Ca, Pb, Cd, Ti, Ni, Ti, Cu, Co, Mn, Sr, Sn, Ba, and Fe. Originally the copper was much higher, but with improved flotation methods this element declined and Zn increased.

Research at Duisberg, leading it appears to large scale operation of the amalgam processes, has lately been described in some detail by Dr. E. Kuss (*Angew. Chem.*, 1950, 62 (22), 519-526—21 November).

#### Neither Method Suitable

For the production of very pure zinc (99.9 per cent or the four-nine Zn) either electrolytic or thermal methods may be used, but the author does not consider either is suited to deal with chloride solutions. He describes in detail the work at Duisberg on the amalgam process that seems also to be applicable to a wide and increasing range of metallurgical operations including: production of pure and granulated zinc, thallium, manganese, separation of lead and bismuth, production of metal powders, manufacture of irons with special magnetic and catalytic

properties, and generally in dealing with complex ores without flotation.

The method was also tried out for zinc white pigment. Zinc amalgam was first prepared, then decomposed in a sodium bicarbonate electrolyte and finally decomposed into zinc oxide and chlorine by heating. Fineness of particle could be carried to any desired degree under suitable working conditions. A very high grade product was obtained, but according to the author market conditions were unfavourable to its development.

He and his co-workers therefore concentrated on metals, and especially zinc, making a thorough study of the rather extensive literature of the subject, and carrying out much original research.

#### Decomposition Unsatisfactory

Thermal decomposition of the zinc amalgam proved unsatisfactory, and serious difficulties were encountered in the electrolytic method. Finally, rotary cathodes were used, as in cadmium electrolysis, and a vertical amalgam cell as first described, apparently, in Honsberg's Polish patent No. 9327/1927. The metal cell developed on these lines, as shown in Fig. 1 herewith, had rotary discs—the lower parts of which

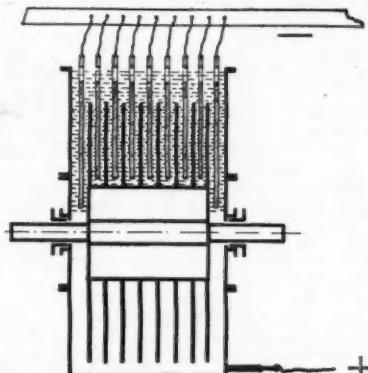


Fig. 1

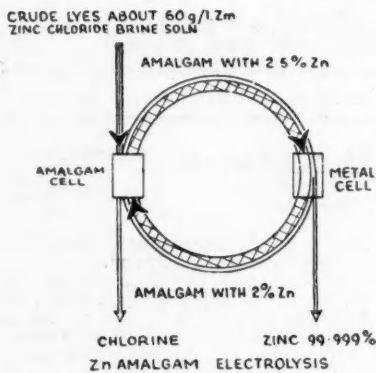


Fig. 2

moved through an amalgam sump and the upper through normal zinc sulphate electrolyte. But in this case—unlike the amalgam discs were anodic and the corresponding aluminium discs cathodic. In this way uniform current distribution as well as effective decomposition of the amalgam were secured, with zinc product of remarkable purity. Somewhat similar amalgam methods have of course been widely described in the literature and form the subject of numerous patents dating back many years; but according to Kuss these earlier records were not very helpful.

It was decided that the process should be in two stages, with a set up as diagrammatically shown in Fig. 2. The zinc chloride is led into the amalgam cell where the zinc ion is conveyed to the mercury cathode. The amalgam then passes to the metal cell where it becomes the anode. The zinc is dissolved in a sulphuric zinc sulphate electrolyte and carried to the aluminium cathode, the mercury acting as carrier only.

Various important factors involved are discussed in detail, the first relating to impurities. As is well known normal zinc sulphate electrolysis is liable to complete breakdown through presence of impurities. In the present case it was rather surprisingly found that the amalgam electrolysis method is practically independent of this particular factor. Zinc solutions containing per million parts 1000-2000 parts of lead, 2000-3000 cadmium, 40,000 or more of calcium, 50,000 magnesium, or many others in smaller proportions had no effect on the end results—a zinc of spectrum purity. Curves show amounts of various metals separating out according to current densities up to 2000 amp./m<sup>2</sup>.

A second factor is current density which, in connection with zinc concentration, is of major importance not only in eliminating impurities but also in recovering the zinc itself. Diagrams in originals show, for various temperatures (23 to 84° C.), undisturbed areas and those areas subjected to (a) cover effect and (b) movement effect, with c.d. ranging from 0 to 2000 amp./m<sup>2</sup>. It is clear that with higher temperatures and Zn concentrations higher c.d. are also permissible. Of the two disturbing effects, that of movement is due to higher current densities with reduced ion content, while coating or covering takes the form of a black film of finely divided zinc—also due seemingly to higher c.d. and favoured too by presence of As and Sb. This latter effect (coating or filming) may be accompanied also by a form of slagging.

This third factor is one of the most inconvenient and troublesome in amalgam chemistry. Its main cause is atmospheric oxygen to which zinc amalgam is very susceptible; and the zinc oxide mixed with Hg forms the undesirable slag. Various counteracting measures were tried, including protection by inert gas such as nitrogen, but without success. Eventually coating of the amalgam with very dilute acid proved fairly effective. This slagging up nuisance is attributed largely to the marked van der Waal effect in mercury. It is in fact strong enough to clog up almost any system, and entrains among other things electrolysis poisons such as graphite from the amalgam to the metal cell.

The other factor—potential or voltage conditions, and hydrogen over-voltage—are discussed at some length, and can only be briefly noted here. Among the main points are the need for maintaining the electrodes liquid in the amalgam process; the grouping of metals according to their potential, as positive, negative, or neutral; potential displacement; current/voltage curves; and the "blocking" effect or retention of impurities. This latter in the case of a zinc amalgam is compared with copper refining by electrolysis: in the latter the refining factor is only 1: 45, whilst in the former it is 1:100,000.

#### Proved Essential

As regards hydrogen over-potential, this has been shown to be essential for the deposition of hydrogen at a zinc cathode. Although the zinc potential in amalgam is little changed the conditions for electrolysis are still more favourable since the hydrogen over-voltage in this case is still higher than for zinc only. With normal

zinc electrolysis, over-voltage, e.g., by facilitating separation of so-called poisons with formation of local "cells", can be easily inhibited, and affect smooth working; but with the amalgam method such local centres cannot form since the cathodes are liquid. Hydrogen behaves at the Hg cathode as if it were not mono-valent but semi-valent, and its potential with increasing pH values of solution will rise. This property together with the potential displacement of the alkaline metals in amalgam formation constitutes the essential basis of alkali amalgam electrolysis. Hydrogen over-voltage may be removed by means of depolarisers. For example, zinc amalgam breaks up somewhat violently with hydrochloric ferric chloride solution with formation of a froth blanket. The collapse of this latter in point of time follows so precisely the zinc content of the amalgam that it has formed the basis of rapid zinc analysis.

The validity of potential series in the case of amalgams has a further important application, especially in cementation or exchange of base metal for noble, a process which takes place with great rapidity. These exchanges also take place with amalgams if care is taken to have large interfaces, e.g., vigorous movement and distribution of the amalgam in the solution, for which purpose a phase exchanger has been developed. Cementation follows the laws of a reaction of the first order, as exemplified by Cd cementation with Zn amalgam. Curves show log. Cd decline in linear relation with time for (a) at 60° C. with 1 per cent Zn in the liquid

amalgam and stirring speed of 300 r.p.m., (b) at 90° without Zn and 275 r.p.m. Cementation with amalgams has the special advantage of gradual quantitative and stoichiometric working. The end point is easily determined by the sudden rise in potential.

The potential curves were measured for amalgam exchange reactions with Zn amalgam plus (a) Cd salt solution, and (b) Tl salt solution by determining the Zn equilibrium potential throughout the whole practical concentration range, and results graphed. It is seen that the potentials are entirely governed by the Zn solution pressure. Only when this is used up is there a potential rise to the level of the next in order noble metal, e.g., cadmium or thallium.

Such strictly stoichiometric exchange reactions are well adapted for rapid and exact analytical determination of the metal content in an amalgam. For example, the Zn content may be found by using a plumbate solution of known lead content the end point being indicated by appearance of turbidity and sludging up of the amalgam due to formation of insoluble cadmium hydroxide from the small quantity of added Cd metal. Methods of dealing with cases in which the potential difference is insufficient for the required separation, e.g., by choice of suitable electrolytes, are described; and several other industrial uses for these exchange reactions are noted, as for example in purifying lyes and liquors. The case of alloy formation and its effect in amalgams is also discussed, with special

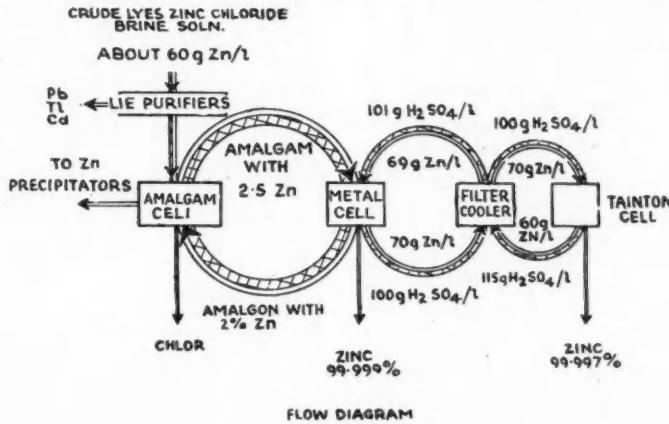


Fig. 8

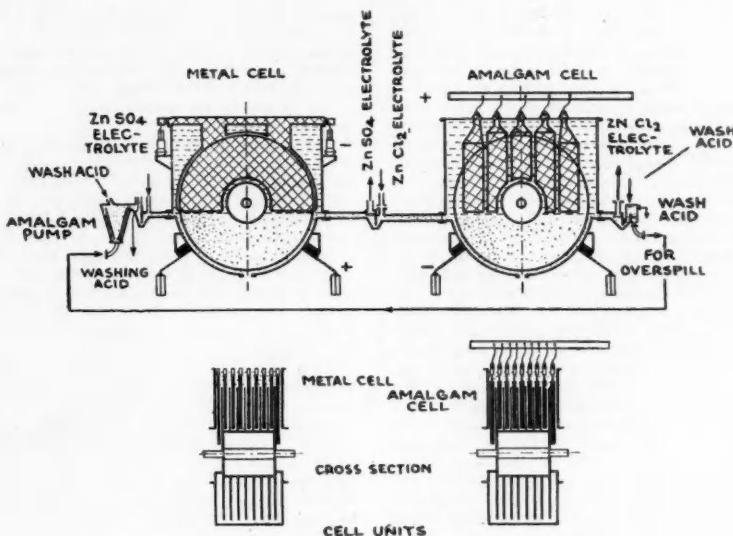


Fig. 4

reference to cementation of metals of the iron group, such as nickel, and of copper, etc. A particularly interesting application of the exchange principle is in indirect electrolysis. Reference is made to sodium amalgam electrolysis coupled with cementation of manganese from manganous solutions. This may form a new cyclic process for Mn recovery.

It is claimed that zinc amalgam electrolysis on an industrial scale has now been achieved, or at all events it is hoped within the near future to finance a large scale plant. Its principal features are shown herewith in Figs. 3, 4, and 5. The first of these is the general set-up indicating the three stages: (1) preparation and decomposition of the Zn amalgam; (2) purifying and cooling electrolyte for the metal cell; (3) enrichment of this cell with zinc so that electrolyte is restored to original concentration. The crude lye containing about 60 g Zn/lit. after preliminary purification is led to the amalgam cell running at 3 volts and 650 amp./m<sup>2</sup> where the Zn content is reduced to 10-12 g/lit. The solution now passes to the enrichment unit or to ZnO precipitators. The Cl formed contains no more than 0.2 per cent hydrogen and may be used in various ways. The amalgam formed is enriched to 2.5 per cent and led to the

metal cell running at 0.45 v and 600 amp./m<sup>2</sup>. Only about 0.5 per cent Zn is removed from the amalgam which now passes back to the amalgam cell, traversing washing sluices in order to avoid slagging. As electrolyte in the metal cell very pure zinc sulphate solution, prepared in the plant itself, is used. The electrolyte must be pure, optically clear, and contain no colloidal matter. The temperature is between 35 and 40° C. The anodic current efficiency is about 100 per cent and the cathodic 95-97 per cent, so that Zn sulphate content increases and sulphuric acid declines. Fig. 4 herewith shows the cell unit. The cathodes of the metal cells have a specific form corresponding to the rotation of anodes, that is to say, semi-circular, with a diameter of about 2 m., and are provided with extensions or screens to prevent unwanted current densities.

The phase exchangers are an interesting feature and are shown in Fig. 5. This has a capacity of 1000 lit. It is fed with 200 lit. of Zn amalgam, and is capable of exchanging 100 kg. Cd in the amalgam from a cadmium sulphate solution (100 g Cd/lit.) with a through-flow of 1 m<sup>3</sup>/hr., so that the exchange reaction

(continued at foot of opposite page)

# AGEING OF ALUMINIUM ALLOYS

## Recent Russian Work

WITH the aid of the electron microscope the ageing of aluminium alloys has been investigated by N. N. Buinov and R. M. Lerinman, of the Institute of Metal Physics, Urals branch, Soviet Academy of Sciences, and results reported in two papers: the first dealing with the initial stages, and the second with formation of thin structures during ageing. (*Doklad.*

(continued from opposite page)

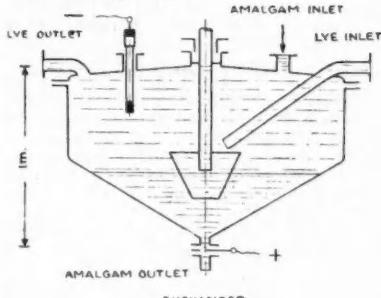


Fig. 5

provides cadmium amalgam almost wholly free from zinc.

The amalgam exchange process is particularly suitable for production of thallium metal from Tl-containing lyes, in view of its high solubility in Hg. In one single exchanger charge about 1 ton Tl may be obtained in the form of a 90 per cent amalgam. By distilling off the Hg very pure thallium metal is obtained. With small modifications the phase exchanger can be used for the purification of solutions, e.g., for the removal of minor quantities of cadmium, thallium, and lead from industrial zinc liquors.

Dr. Kuss emphasises that the design and construction of the plant used on a pilot or semi-large scale involved serious practical difficulties that were, however, for the most part eventually overcome. In conclusion, a general scheme is shown for a proposed large-scale plant to produce 10,000 tons zinc per annum. In this a special feature is the adoption of protective measures against mercury contamination of the atmosphere by effective ventilation; also by wetting the floors with slightly acidulated water.

*Akad. Nauk, SSSR, 1950, 74 (4), 707-10; (5) 929-931.* Alloys examined were Al-Cu (4 per cent Cu by weight) Al-Ag (10 per cent Ag), and Al-Mg-Si (1.4 per cent Mg-Si), and in much of the work the now well known oxide replica method was employed.

The electron picture obtained with chilled specimens of the Al-Cu and Al-Ag alloys exhibited the presence of light points appearing as traces of sub-microscopic particles of new phases, probably phase  $\theta'$  rich in copper atoms and phase  $\gamma'$  rich in silver atoms respectively. They were evidently formed in the chilling process, the time elapsing from this operation to that of obtaining the replica being reduced to four minutes. This suggests that the first stage of dissociation in these alloys occurs with great rapidity. Linear measurements of these formed or separated particles\* in the Al-Cu alloys were of the order of 50 to 200 Å, the most common being 100 Å. Average size of these does not appreciably change with time of natural ageing. Their form is roughly equi-axial or somewhat elongated (length/width 3 : 1). These alloys were water-cooled from 540° C., and show deep etching or corrosion. In the Al-Ag alloys, naturally aged for 70 days and electro-polished, the particles had no clearly defined contour, but their size was about the same as in the Al-Cu alloy, and appeared to change little if at all. Results so far seem to show that the explanation of slope of curve: electric resistance/time of ageing, for Al-Cu alloys put forward by Mott<sup>2</sup> and Konobeevskii<sup>3</sup> has not been experimentally confirmed. If there is no change in the size of particle in naturally aged material there is little or no ground for relating changes in electro-resistance with changes in grain (particle) dispersion. The observed rise in resistance is doubtless due to formation of highly dispersed systems, and is associated with rapid increase in hardness. A fall in resistance, on the other hand, is probably connected with delayed formation of new systems or phases and with internal structural changes occurring in solid solutions, e.g., an equalising of local concentrations of heterogeneity.

### Internal structural changes in duralumin

\* This term, formed or separated, or new-phase particles, refers actually to light points, specks, or streaks, in this picture; but it is possible that they are still only traces of embryonic new phases coherently united with the matrix of solid solution, and not particles of completely isolated new phases.

in natural ageing have been noted earlier<sup>4</sup>. It was observed that the intensity of the interference lines in X-ray diagrams of chilled duralumin after natural ageing increased, e.g., after 10 hours the ageing line increased by 1.7 per cent. At the same time there was fading of the general background. Possibly these particle systems are disposed at the boundaries of submicro mosaics that are more readily observed in electro-polished and slightly etched test-pieces or replicas thereof. With deep etching, besides the "formed particles" little chains thereof could be observed along the boundaries of groups.

In the Al-Mg-Si alloys, both after chilling and after natural ageing (up to 3 months) "new phase particles" were not observed while hardness appreciably increased. It is possible that the grains are too small even for the electron microscope. Higher dispersion with these alloys than in those of Al-Cu or Al-Ag was to be expected. In the Al-Cu and Al-Mg (Al-Ag?) alloys aluminium itself took part in formation of "new phase particles." This doubtless facilitated their formation since the Al atoms had no further to travel than the parameter of the crystalline pattern (and only of atoms of Cl or Ag); in the case of Mg<sub>2</sub>Si grains the distance was appreciably greater. Concentration was low, and the formation of "new phase particles" occurred only after ageing at 150° for an hour.

#### Can Discern Break-Down

Comparing these results with those in the literature<sup>5,6</sup> it seems that, with the electron microscope, it is possible to discern break-down or dissociation in all three alloys at earlier stages than by X-ray means. The amount of precipitated particles in individual grains was not uniform, especially in the Al-Cu alloy; and this applies also to their distribution within one grain. Thus the difficulty of observing break-down kinetics were increased. This in turn is probably connected with irregular distribution of distortion in the crystal lattice.

It is difficult to give a quantitative explanation from results of prolonged ageing of Al-Cu and Al-Ag alloys at room temperature, owing to irregular distribution of changes and formations. Pictures obtained with specimens naturally aged during several months differ little from those obtained with chilled specimens. All that can be said is that, in the Al-Cu alloys absence of separated particles was more frequent than their presence, and where they did appear it was less marked than with test-pieces subjected to prolonged

natural ageing. It was therefore difficult to relate changes in their number with time of ageing.

By annealing the alloys Al-Cu and Al-Ag at relatively high temperatures of 150–200° C., flake-like formations appeared as shown in micro-photographs of original; but with the Al-Mg-Si alloys these were of rod-shape form. It should be noted that similar forms, as regard the first two alloys, have been found with X-rays.<sup>7</sup> These apparently are only seen at ageing temperatures of 150–200° C., the reason for which is difficult to explain. They first appear at the grain boundaries of micro-mosaic and then within these boundaries; but there are slight differences between the Al-Cu and Al-Ag alloys. In the latter they appear oriented in the direction of the cubic mosaic groupings.

#### Two Processes Exist

From the foregoing kinetic study it should be possible to explain the nature of two maxima in the curves hardness/ageing time.<sup>8</sup> Since dissociation during artificial ageing at first occurs at the boundaries of mosaic groups and then within those boundaries, to that extent one may suppose the existence of two processes. These, partly at least, overlap, and thus reinforce certain points in the curve, accounting for existence of two maximum peaks. This explanation seems to conform with the electron-microscope picture. In these hardness/time ageing curves obtained at higher temperatures there is only one maximum. Accordingly the authors were unable to discover, in the Al-Cu alloys—even with very brief periods of tempering at temperatures of 350° C., preferential breakdown at the mosaic group boundaries. Probably at high temperatures the second process takes place rather more quickly than the first. Some factors connected with disintegration or breaking up of the mosaic groups, deformation, and elasticity, are discussed briefly, in relation also to hardness, with formation of further sub-micro mosaics, in the process of ageing. These may assist in the formulation of a theory of strengthening both in plastic deformation and in ageing of alloys as already suggested in the literature<sup>9</sup>.

It should be observed in conclusion that the appearances of manifestations seen within the grains and at group boundaries of micro- and submicro-mosaics in the form of white specks and flakes, are almost entirely absent at the grain boundaries themselves. Here can be seen merely somewhat coarse indefinite appearances (formations) of 0.1 to 1 micron of different forms and orientations. Their size, how-

ever, increases with temperature and time of tempering.

The break-down of super-saturated solid solutions of the same series of aluminium alloys at relatively high temperatures of 150–200° C. and higher was studied with the electron microscope. With the Al-Cu alloys at this temperature formations in the first phase were of the flake type with certain orientations corresponding to their structure parallel to cube faces. Linear dimensions of these flakes and their form depended on temperature and time of annealing. Thus with temperature of 180° C. and according to time their length ranged from a few hundred Å to one micron, and thickness from 50 to 200 Å. Examined with the electron microscope the flakes were definitely of thin fine structure and the picture often showed a single layer of particles of the same form as that of specimens naturally aged<sup>10</sup>; so that, as already suggested by Konobeevskii<sup>11</sup>, processes taking place may be identical character.

With still higher annealing temperatures larger flakes were formed. For instance, at 350° C. their length was one to a few microns and thickness up to 400 Å. In some cases flakes form along two faces of cube, or even slightly along three faces. Their dark outlines are probably due to remaining traces of corrosion products (etching). These flakes seem to consist of individual particles of dimensions approximating those of the flakes themselves, similar to those in natural ageing, but always elongated and more sharply developed. The constituent elements are often merged or fused together forming continuous layers and laminae (flakes). In some cases it was possible to observe also particle formations probably due to oxidation.

The flake formations in the Al-Ag alloys were parallel to the octahedron faces, and, like the Al-Cu alloys, were often of thin fine structure, i.e., consisting of individual particles. After annealing at 210° C. linear dimensions were between 400 Å and one micron and in thickness were from less than 100 Å to 200 Å, while constituent elements were 100–200 Å—sometimes 300 Å in length and 50–100 Å wide. Signs of oxidation were also apparent in this picture.

#### Orientated in Parallel

In the Al-Mg-Si alloys at 200° and higher the formations or precipitations were in the form of bars or rods orientated in parallel to the cubic axes. In the replicate it was possible to observe both precipitated particles (traces of) and oxidised

particles. These rod-shaped appearances are probably associated with orientation of chemical (ionic) bonds in Mg<sub>2</sub>Si—it is suggested that the precipitated particles appear as such bonds or combinations. As with the other two classes of Al alloy, the light streaks are often of thin fine structure. In such cases they evidently appear as traces of imperfectly formed rods consisting of elongated particles. These are disposed in the rods either lengthwise or transversely, but always parallel to one cubic axis.

Analogous pictures are to be seen in the Al-Cu and Al-Ag alloys. In the flakes of the former the particles are orientated parallel to one of the faces, but in the latter parallel to a face. It seems that the rod-shaped and flake precipitations are so formed that, independently of their orientation, the orientation of their constituent elements remains invariable within the limits of a single crystal. Probably the orientation of the flake and rod constituent elements in these alloys is closely connected not only with crystal symmetry but also with the anisotropic nature of deformation distribution in the crystalline lattice.

#### Length of Particles

In the Al-Mg-Si alloys annealed at 200° for 1 to 5.5 hours the length of these particles constituting the flakes is 200–300 Å and with 50–100 Å. Annealing at higher temperatures tends to enlarge these particles; they become relatively shorter and more fused together. In the rod-shaped formations of a new phase there is often one and sometimes two larger flakes around which are finer particles of the same length. These latter in proportion as they are removed from the coarser particles decrease in thickness and are often disposed close together so that finally they coalesce into one common band or streak. The whole trace of not fully developed rod-like form often suggests the optical spectrum. One may suppose that the coarser particles originated at the very beginning of decomposition, and their formation and growth stimulated further development of new particles orientated along the cubic axis. Evidently they may be regarded as centres or nuclei from which subsequently arise the rod forms also orientated along the cubic axis.

In these rod-like forms of the Al-Mg-Si alloys and the flake forms of the Al-Cu and Al-Ag alloys directly visible in the picture there is no noticeably thin fine structure. It is possible that their constituent elements have already become merged, similar to the merging of antiphase zones in the process of "regulating" alloys. The

appearance and growth of new phases in the alloys herein discussed may be regarded as analogous to that occurring in "regulating" such alloys at Au-Cu<sup>12</sup>. Embryonic or nucleonic "regulating" phases in this class of alloy have a tetragonal lattice, and they may be supposed to form in the following manner:—

#### Favourable Conditions Established

The emerging embryonic form with tetragonal lattice in the direction of its c axis ( $c < a$ ) elongates the matrix lattice; but in the direction of axis  $a$  (in regulated phase  $a$  is greater than in the non-regulated) it is compressed. As a result favourable conditions are established for the emergence of new embryonic regulated phases with other orientations of axes  $c$  and  $a$ , since, in the matrix arise deformed zones having a tetragonal lattice. Along the new embryonic axis  $c$  orientation will be in the direction of compression, but along  $a$  it will be that of extension. The new nucleus (embryo) in turn during growth will likewise cause deformation of lattice and will thus stimulate subsequent changes or formations.

Between these originating regulating phases there should be also unregulated zones, since two regulated zones with different orientations cannot co-exist crystallographically in one plane (face). Thus, at the very start of regulating there must arise disconnected embryonic regulated phases. The appearance of these new phases in the alloys herein examined in the initial stages of decomposition indicates that they have lattices differing from those of the matrix, and therefore the picture of their formation, evidently, may be the same as that of the initial stage of regulation in alloys. Probably other alloys will show the same pictures of origin and growth of formations and changes.

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- <sup>11</sup> S. T. Konobeevskii: *A.H. E.T.P.*, 1943, 13, 185.
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#### OBITUARY

MR. WILLIAM BROWN BELL, president of the American Cyanamid Company, died at Marakeesh on 20 December, while travelling through North Africa. Mr. Bell was born in Pennsylvania in 1879. He was a graduate of Haverford College, School of Political Science of Columbia, Columbia University of Law, and for a time practised law in New York. Mr. Bell served as president of the American Cyanamid Company since 1922 and was responsible for building a great industrial enterprise. In 1949 he was awarded the Medal of the Society of Chemical Industry for distinguished service to the chemical industry. He was former chairman of the Board and president of the Manufacturing Chemists' Association and Chemical Alliance and was honorary vice-president of the National Association of Manufacturers. He held numerous directorships in banks and industrial companies.

Mr. Bell was actively interested in education. He travelled extensively and spoke and wrote much on economic subjects. At one time he was chairman of the Republican National Finance Committee.

#### Virgin Aluminium Price Increase

THE price of virgin aluminium ingot form was increased on 1 January from £120 to £124 per long ton delivered, according to an announcement made by the Ministry of Supply. For metal in notch bar form there will be an addition of £2 10s. a ton as previously.

The increased price will apply to metal of a purity of 99 per cent to 99.5 per cent, inclusive. There was no change in the premiums to be paid for higher purities, which were:—

	Purity Per cent	Premium per ton additional to ingot or notch bar price
Minimum	99.6	£8
"	99.7	£12
"	99.8	£17
"	99.9	£50

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## KEY INDUSTRY DUTY

A N Order has been made continuing from 1 January until 31 March 1951, the exemption of ethylene glycol ethers from Key Industry Duty. The Order also continues from 1 January until 19 August 1951, the exemption from Key Industry Duty of all the articles exempted from that duty by previous Orders which expire on 31 December 1950 (except ethylene glycol ethers) with the addition of:

p-chlorophenol, dimethylamine, lithium hydroxide, methyl methacrylate, 4-methylpentanol-2, R. sulphuric acid, zirconium oxide;

and with the deletion of:

amyl acetate, anisaldehyde, cocaine hydrochloride, dichlorodifluoromethane, diethylaminoethyl alcohol, n-octanol-2, phenylmercury acetate, sebacic acid, sodium nitrobenzenesulphonate.

The Order is the Safeguarding of Industries (Exemption) (No. 15) Order, 1950, and is published as Statutory Instruments 1950 No. 2105.

### Added to the List

The Board of Trade has added the following 38 chemicals to the list of chemicals liable to Key Industry Duty:

Amidone, amidone salts, barium dihydroxystearate, benzotrifluoride, calcium dihydroxystearate, R. cetyl myristate, R. cetyl oleate, R. cetyl stearate, chelidamic acid, monochlorodifluoromethane, dicetyl ether, 5:5'-dichloro-2:2'-dihydroxydiphenylmethane, dichloromonofluoromethane, n-(2-Diethylaminoethyl) phenothiazine, n-(2-Diethylaminoethyl) phenothiazine salts, n-(2-Diethylamine-n-propyl) phenothiazine, n-(2-Diethylamino-n-propyl) phenothiazine salts, n-(2-Dimethylaminoethyl) phenothiazine, n-(2-Dimethylaminoethyl) phenothiazine salts, n-(2-Dimethylamino-n-propyl) phenothiazine, n-(2-Dimethylamino-n-propyl) phenothiazine salts, 1:1-diphenyldiethyl ether, n-Ethylpiperidine, hexamethonium bromide, hexamethonium iodide, lithium dihydroxystearate, mepyramine, mepyramine salts, methanesulphonic acid, methyl amyl ketone, nonoic salts, pentamethonium bromide, propylene glycol esters, trichlorofluoromethane, Trichloromethylphenyl carbinol, trichloromethylphenyl carbinyl acetate, trifluoroacetic acid, undecenoic salts.

The Order, which comes into operation on 1 January 1951, is published as Statutory Instruments 1950 No. 2085.

## SULPHUR ALLOCATIONS

EXPORT quotas of sulphur from the U.S. to foreign destinations during the first quarter of 1951 were recently limited to 207,500 tons. Of this total, 200,000 tons will consist of crude sulphur, while the remaining 7,500 tons will be refined sulphur.

Allocations for the first quarter of 1951 are as follows:

	Quota Distribution (in tons)
The Far East :	
India	8000
Pakistan	130
Indonesia	700
American Republics :	
Argentina	3800
Brazil	11,375
Colombia	175
Mexico	400
Ecuador	2000
Uruguay	400
Netherlands West Indies	2600
Western Europe :	
Austria	2500
Belgium	13,000
France	20,125
Germany	3000
Portugal	130
Sweden	1250
Switzerland	3000
United Kingdom	81,465
Australia and New Zealand :	
Australia	18,125
New Zealand	13,125
Near East and Africa :	
Egypt	800
French North Africa	3000
Iran	880
South Africa	10,000
Contingency needs	5000
	<hr/> 200,000 tons

### Chile to Complete Smelter

The government of Chile has allocated 37 million pesos to continue the construction of the metal smelting plant at Paipote near Copiapo in the north of the country. A Bill is also to be drawn up, proposing expenditure of about 243 million pesos for the completion of the plant. The construction of this smelter, which was started in 1947, is intended to stimulate the activities of the small and medium-sized mining enterprises whose ore output at present has to be shipped abroad for refining. The annual capacity of the plant is 142,000 tons of ores and concentrates, giving a production of 20,000 tons of copper, 1.4 tons of gold and 3.5 tons of silver.



**FRictional PHENOMENA.** A. Gemant. 1950.  
New York: Chemical Publishing Co., Inc. Pp. 497. \$12.00.

The retardation of the relative motion at a common boundary of two solid bodies was historically the effect to which the name "friction" was first given. Later the concept of internal friction was introduced to explain the viscosity of gases and liquids, and other phenomena.

In the present treatise, which covers friction in all its manifestations, external friction occupies a relatively small place in spite of its acknowledged importance. The author has been able to present a fairly satisfactory theory of gaseous, liquid, and internal solid friction, but in view of the non-existence of a generally accepted theory of external friction no attempt has been made to give more than a plausible mechanism for it and some of the recent experimental data.

The book is divided into five parts of unequal lengths. The first deals generally with the concept of friction and includes an outline of the mathematical treatment of frictional phenomena, the last consists of problems with solutions. The other sections embrace all frictional processes under the main headings of gases, liquids, and solids from both theoretical and practical points of view. The ground covered is extensive and the topics dealt with touch nearly all branches of physics and engineering. It is pointed out that friction is necessarily involved in the description of all physical processes with the possible exceptions of the astronomical and the intra-atomic.

The discussion of frictional phenomena in gases covers kinetic theory, gaseous viscosity, absorption of sound waves, and supersonics, with applications to molecular pumps, measurement of pore size, room acoustics, sound-proofing, etc. With liquids, the main theories of viscosity with relevant experimental data and the various techniques of viscosity measurement by capillary, oscillation, rotation, and falling sphere methods are described, and there are chapters on the viscosity of colloidal solutions, structural viscosity, engineering applications concerned with

the flow of liquids in pipes, etc., electrical insulating liquids, and the theory of film and boundary lubrication. Plastic flow, internal friction, damping capacity, and related phenomena of solids are considered at great length. This section contains a review of plasticity and engineering applications in addition to external friction and its uses.

The book is well illustrated with diagrams and graphs, and is clearly written. It does not require previous acquaintance with the subject, and the mathematics is mostly of an indicative and substitutional character. Extensive and up-to-date bibliographies at the end of each chapter render the text very valuable for reference purposes. The author has produced a reasonably comprehensive treatise on viscosity and plasticity of matter. It seems possible, however, that the title may cause the book to escape the notice of many who would be interested in its contents.—G.S.S.

**CHIMIE ORGANIQUE III.** By A. Kirrmann. Paris: Librairie Armand Colin. Pp. 188. Fr. 180.

This third volume, the second part of descriptive organic chemistry, deals with compounds having several identical or different functions in their molecules. The original and very systematical plan of the book considers the grouping two by two of all the simple fundamental functions, taking into account solely the pure chemical interest of these bodies and excluding their practical importance. As a contrast, the compounds with more than two functions only appear as pure coincidence.

This small volume, which is handy, clear and concise, and which contains an alphabetical index of all the compounds dealt with therein is a book for specialists, students, chemists and biologists as well as for engineers and industrialists to whom the fundamental notions of organic chemistry are essential in the fulfilment of their work. It also gives a complete modern picture of the study of organic chemistry to those who are curious for chemical knowledge.—F.N.

# • PERSONAL •

**MR. P. C. CHAUMETON, B.Sc., F.R.I.C., M.I.Chem.E.,** has been elected a director of Petrochemicals, Ltd.

**DR. KARL T. COMPTON,** chairman of the Corporation of the Massachusetts Institute of Technology, has been nominated as first recipient of the \$1000 William Proctor Prize for Scientific Achievement. The award, established this year by Dr. William Proctor, of Bar Harbour, Maine, is given in recognition of achievement in research in natural science or engineering, or for the administration of such research. Dr. Compton is being honoured not only for his administration as president of the Massachusetts Institute of Technology from 1930 to 1948, but also as chairman of various national committees concerned with research, and for his own scientific investigations.

**MR. J. MATTHEWS,** manager of the A.P.V. Dairy Engineering Department, and **MR. MADRON SELIGMAN,** director of Paramount Alloys, Ltd., of Slough, have been appointed as directors of the A.P.V. Co., Ltd., on the retirement of **MR. T. H. CLOUSTON.**

**DR. ALEXANDER FLECK, D.Sc., F.R.I.C.,** has been appointed a deputy chairman of Imperial Chemical Industries, Ltd., as from 1 January. The doctor, who was delegate director, Synthetic Ammonia and Nitrates Co., Ltd., from 1929 to 1931, became in that year managing director of the General Chemicals Division, which position he held until 1937. From 1937-1945 he was chairman, Fertiliser and Synthetic Products, Ltd., Billingham Division. He became director, main board of I.C.I., responsible for Billingham and Wilton in 1944 and chairman, Scottish Agricultural Industries, Ltd., three years later.

### Obituary

The death has occurred in Bournemouth of **MR. FREDERICK W. RICHARDSON,** former Bradford and West Riding County analyst. He was 90. Mr. Richardson went to Bradford 72 years ago and was appointed public analyst in 1897. He became West Riding public analyst in 1905 and retired in 1948. He was a keen student of biochemistry and a Fellow of the Royal Institute of Chemistry. He was a member of many scientific societies, as well as of the Athenaeum Club and the Swedenborgian Church.

**MR. HUBERT NAPIER ROBSON,** sales director of James A. Jobling & Co., Ltd., Wear Glass Works, Sunderland, died on Thursday, 28 December, at his home, Forest Lodge, Woodlands, near Consett, County Durham.

Mr. Robson, who was born in 1893, came of the old Scottish family of Gordon, of Musselburgh. From 1919 to 1927 he was a member of the sales staff of Cerebos, Ltd., of Greatham, West Hartlepool, leaving that firm in 1927 to take up the position of sales manager to Suchards, the chocolate manufacturers.

In 1929 Mr. Robson was appointed sales and advertising manager of James A. Jobling & Co., where he contributed much to the marketing and popularising of Pyrex Brand oven-glass and scientific glassware. For several years past he has been a member of the Executive Committee of the Glass Manufacturers' Federation, in which position his wide knowledge of the glass trade proved of great value to the trade in general. Mr. Robson was appointed to the board of Jobling's as sales director on 10 August 1949, and his death at such a comparatively early age will be much deplored by all who knew him, whether in business or socially.

The death was reported this week of **PROFESSOR JAMES FREDERICK SPENCER, M.A., Ph.D., D.Sc., F.R.I.C., Emeritus Professor of Chemistry at London University.** The professor, who was born in 1881, was educated at University College, Liverpool, the University of Breslau and University College, London. He was Leblanc medallist and, an 1851 Exhibition Scholar. After being head of the department of physical chemistry 1919, he became university professor of chemistry, Bedford College, University of London, and head of the department of inorganic and physical chemistry, and director of the chemical laboratories until his retirement in 1946.



H. N. Robson

# • HOME •

### **U.K. Light Metal Statistics**

Ministry of Supply statistics relating to the U.K. production, imports and consumption of light metals in October include the following (in long tons):— Virgin aluminium: production 2534, imports 19,560. Secondary aluminium: production 8184. Aluminium scrap arisings 8257, consumption 10,633. Aluminium fabrication 22,011, foil 1062. Magnesium fabrication 345.

### **Gifts to Leeds University**

At a recent meeting of the Leeds University Council gifts accepted included £1500 from the Royal Society for the purchase of equipment for research; £200 from Imperial Chemical Industries, Ltd., for the purchase of equipment; £262 10s. from B.I.S.C. (Ore), Ltd., London, to the Department of Mining, as an acknowledgement of survey work carried out in the Shetlands; £600 from Courtaulds Ltd., to the Department of Textile Industries, for work undertaken by certain members of the staff; £250 from Courtaulds, Ltd., and equipment to the value of £260 from Imperial Chemical Industries, Ltd., to the Department of Colour, Chemistry and Dyeing.

### **Technical College Appeal**

An appeal for £350,000 for the extension of the Royal Technical College, Glasgow, will be inaugurated at a reception to be given by governors of the college on 15 January. The appeal will be commended by the Lord Provost of Glasgow, Col. Victor Warren, and will be supported by Mr. T. Muir Wilson, chairman of the Federation of British Industries (Regional Council), and Mr. Harry Yates, president of the Glasgow Chamber of Commerce. The estimated cost of the complete building is £750,000, and the governors wish to start at once with the first stage of the development, which is estimated to cost £45,000. Government grants amounting to £334,000 have already been announced.

### **Scottish Sulphuric Acid Plant**

Scottish Agricultural Industries Ltd. are to install a large new pyrites-burning sulphuric acid plant in the city of Aberdeen which will make enough acid for all the super phosphate required by the North East and North of Scotland. It is indicated in the annual report of the company that the plant will be of a type new in Britain and that it will replace existing plant at the Sandilands works of

the company. During the past year the firm has been forced to buy extensively outside their own organisation and recent events in America and elsewhere have created a situation which demands a larger volume of production. When in use the new plant will help to increase or at least maintain the rate of production of superphosphates which has suffered as a result of the decline in the volume of sulphuric acid available to the industry. The company has also decided to create a centralised research laboratory to investigate phosphates and fertilisers on a larger scale than formerly.

### **Scottish Diatomite Progress**

The diatomite industry is making good progress in Scotland. Raw materials are now being mined fairly extensively in Skye from the Loch Cuirthir deposits opened up in 1948 by Scottish Diatomite, Ltd. Despite adverse weather conditions a fair volume of diatomite of good quality was taken out last year and a considerable amount of constructional work was begun. The manufacture of diatomaceous silica filters is also progressing in Scotland. This again is a relatively new industry; its importance and the value of the industry to the country lies in the growing field of application. One Glasgow firm handles production from the raw material stage to the kilning and finishing. Diatomaceous filters are being used extensively in brewing, water filtration, in the filtration of compressed air used for the movement of liquids, for food industry purposes and in many other chemical and allied industries. At present a fair volume of the diatomite in use is imported but it is hoped that more indigenous diatomite will soon become available. In addition to diatomaceous types, a whole range of ceramic filter units is being produced in Scotland.

### **BISOL Chemical Products**

Owing to rises in raw material costs, the prices of a number of BISOL organic chemicals have recently been increased.

Revised prices (minimum 1 ton or under 10 tons spot or contract over a calendar year, carriage paid, packages returnable at seller's expense) are (per ton):—

Diacetone alcohol, £132; Methyl ethyl ketone, £115; Mesityl oxide, £174; Amyl lactate, £390; butyl lactate, £390; Tributyl citrate, £332; Butyl oleate, £275; ethyl oleate, £249; Butyl stearate, £286; diethyl tartrate, £406; Dibutyl tartrate, £378.

# • OVERSEAS •

### New U.S. Taconite Project

The Republic Steel Corporation and the Armco Steel Corporation are to develop a vast deposit of low grade magnetic taconite iron-ore at Mesabi, Minnesota. The ore, which is estimated to total 1500 million tons, is to be mined by the open-cast method. Development will cost about \$160 million.

### Swedish Ironworks Expansion

The expansion of the Sandviken Iron-works, started in 1946, is now almost completed. A new hot rolling mill for strips up to 30 centimetres wide has started production. Stated to be the first of its kind in Scandinavia, it has an annual capacity of 18,000 tons. Another mill, with a capacity of 10,000 tons p.a. of rolled tubing, is to start production shortly. Extensions to the cold-rolling mill will bring its capacity for steel strip up to 18,000 tons a year.

### New Sulphide Ore Furnace

A new type of furnace for the roasting of complex sulphide ores has recently been demonstrated in Pretoria, South Africa, before Government mining experts from South Africa and Rhodesia. According to the inventor, Mr. C. J. Pearton, complete and accurate control of temperature is achieved and the formation of other compounds of sulphide is avoided. Moreover, it is simple to operate and cheap to run. The new roasting method will first be applied to gold mining, but may be used later for treating base metals and producing industrial oxides. The process has been patented.

### New Limestone Works for Sweden

A new limestone works is to be built at Rättvik, in Central Sweden, at a cost of about Kronor 4 million, by Stora Kopparbergs A/B. The company claims that, in the past, the Scandinavian lime market has been dominated by Denmark and Finland because of their more modern plant. Products from the new Swedish plant will feed, among other industries, the nearby Domnarvet Iron Works.

### U.S. Titanium Plant

A large scale titanium production plant, estimated to cost between \$15 and \$20 million, is being planned by the National Lead Company. An 80-acre site with seven buildings, located at Henderson, Nevada, has been leased from Basic Magnesium, Inc. Production would require considerable electrical energy, and a contract has been made with the Colorado

River Commission for the delivery of power to the site.

### Hardening Stainless Steel

A new process which, it is claimed, increases the hardness of stainless steel threefold has been developed by scientists in the laboratories of the Westinghouse Electric Corporation, Pittsburgh, Pennsylvania. The new method involves a unique low temperature treatment. The steel is immersed in liquid nitrogen baths at 300 degrees below zero and rolled or forged at sub-zero temperatures. Heating at controlled temperatures then adds to the hardness. The new hardened stainless steel is expected to have wide use as a wear-resistant material in bearings, valve seats, springs, and other machine parts.

### Synthetic Blood Plasma Patents

Three German patents useful in producing synthetic blood plasma have been released for general royalty-free use in the United States, according to the U.S. Department of Justice. The patents were originally seized by the U.S. Office of Alien Property from I.G. Farbenindustries during the war as enemy property held in the United States. The patents relate to the manufacture of polyvinyl pyrrolidone, which is reported to be an essential ingredient in the production of synthetic plasma.

### New Swedish Cellulose Process

Fengersfors paper mill in Dalsland, Central Sweden, claims to be the first in the world to have introduced the continuous boiling of cellulose. The patent for the process is held by a subsidiary of Karstads Mek. Werkstad and the process was first tried out in the State Forestry Industries plant at Kalix. At Fengersfors, a single boiler 19 metres long and with a capacity of 65 cubic metres is used. The wood chips are first fed into a chamber for singeing and then into the boiler where the pulp is extracted. The pulp is then led off into a blowing tank and from there it is finally run out into the washing filter. The boiler is manned by only two men who feed chemicals into it and ensure maintenance of proper temperature. The process is continuous and avoids the usual frequent emptying of the boiler with the attendant stoppage and refilling. Under equal conditions, this new process is claimed to increase output by 25 per cent compared with the usual processes.

## Next Week's Events

**MONDAY, JANUARY 8**
**Royal Society of Arts**

London: John Adam Street, Adelphi, W.C.2, 6 p.m. First of Three Cantor Lectures by J. C. Swallow, of the Research Department, I.C.I., Ltd., Plastics Division: "The Plastics Industry."

**TUESDAY, JANUARY 9**
**The Institution of Chemical Engineers**

London: Burlington House, Piccadilly, W.1, 5.30 p.m. C. J. Stairmand: "The Sampling of Dust Laden Gases."

**Hull Chemical and Engineering Society**

Hull: Church Institute, 7.30 p.m. A. P. Backshell: "The Chemists in Fiction, in Fact and in the Future."

**The Royal Institute of Chemistry**

Gravesend: Royal Clarendon Hotel, 7.30 p.m. J. Smith: "Atomic Reactors—Their Development and Economics."

**Institution of Works Managers**

Birmingham: Grand Hotel, 7 p.m. E. A. Murphy: "Modern Developments within Industry (Plastics and Rubber)."

**WEDNESDAY, JANUARY 10**
**Society of Chemical Industry**

London: 11 Chandos Street, Cavendish Square, W.1, 2.15 p.m. (With Society for Applied Bacteriology) "The Cytology of Bacteria."

**Royal Society of Arts**

London: John Adam Street, Adelphi, W.C.2, 2.30 p.m. C. Potter and T. Wallace: "Insecticides and their Study."

**Institute of Welding**

Manchester: Reynolds Hall, College of Technology, 7 p.m. R. Bushell: "Applications and Developments with Resistance Welding."

**THURSDAY, JANUARY 11**
**Oil and Colour Chemists' Association**

Hull: Royal Station Hotel, 7.30 p.m. (With RIC) L. J. Williamson: "The Design and Operation of Laboratory Fractionating Columns."

**The Chemical Society**

Bristol: The University, 7 p.m. (With RIC and SCI) Quickfit & Quartz: "Modern Laboratory Glass Apparatus."

**Pharmaceutical Society (Junior Branch)**

Manchester: 16 St. Mary's Parsonage, 7.30 p.m. Technical I.C.I. Film Show.

**FRIDAY, JANUARY 12**
**The Chemical Society**

St. Andrews: United College, 5.15 p.m. Dr. R. A. Raphael: "The Synthesis of Some Natural Products by Means of Acetylenic Compounds."

**Oil and Colour Chemists' Association**

Manchester: The Engineers' Club,

Albert Square, 6.30 p.m. Dr. F. H. Kroch: "Leather Finishes."

**SATURDAY, JANUARY 13**
**Institution of Chemical Engineers**

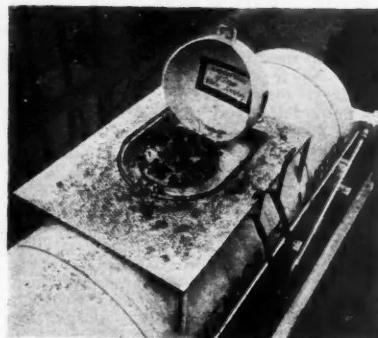
Birmingham: The University, Edmund Street, 3 p.m. F. H. Garner and S. R. M. Ellis: "Applicability of Vapour Liquid Equilibria to Extractive Distillation."

### TRANSPORTING ETHYLENE OXIDE IN BULK

TEN highly specialised rail tank cars for carrying ethylene oxide in liquid form, and under pressure, have been built by British Railways (London Midland Region), in co-operation with Petrochemicals, Ltd.

The tank cars, which have been constructed to accord with Home Office and Continental requirements, will be used to transport ethylene oxide between Partington and certain Continental destinations via the Harwich-Zeebrugge train ferry service.

The capacity of each tank car is 7.5 tons of liquified gas. All plates are welded, having been examined by X-rays at each stage of manufacture.





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## Law and Company News

### Commercial Intelligence

The following are taken from the printed reports, but we cannot be responsible for errors that may occur.

#### Mortgages and Charges

(Note.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described herein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every company shall, in making its Annual Summary, specify the total amount of debt due from the company in respect of all Mortgages or Charges. The following Mortgages or Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an \*—followed by the date of the Summary, but such total may have been reduced.)

DAMANCY & CO., LTD., Harrow, manufacturing chemists. (M., 6/1/51). 4 December, £10,000 mortgage to Mrs. M. M. Severne, London, and another, and £8000 mortgage and £4000 debenture, both to M. W. Severne, London; respectively charged on factory and premises at corner of Crib Street and Coronation Road, Ware, the same and a general charge. \*£3469. 11 August 1950.

INDUSTRIAL FAN & HEATER CO., LTD., Birmingham. (M., 6/1/51). 27 November, mortgage and charge, to Midland Bank, Ltd.; charged on premises known as Pyramid Works, Evelyn Road, Greet, Birmingham, with machinery, fixtures etc., also a general charge. \*Nil. 15 December, 1949.

SOZOL (1924), LTD., London, E.C., manufacturers of chemical preparations. (M., 6/1/51). 30 November, three charges, to Barclays Bank, Ltd.; respectively charged on 10 and 12 and land at Browning Street, Bradford. \*£800. 30 December, 1949.

SPINKS PURE DRUG CO., LTD., Hull. (M., 6/1/51). 1 December, charge, to Barclays Bank, Ltd.; charged on land and factory buildings, National Avenue, Hull.

YORKSHIRE LIMESTONE CO., LTD., Womersley. (M., 6/1/51). 29 November, £1000 mortgage, to Mexborough Investment Co., Ltd.; charged on limestone quarries and buildings at Stapleton, near Pontefract (subject to etc.). \*Nil. 27 September, 1949.

#### Satisfactions

DEXTRAN, LTD., Darlington, manufacturers of plasma substitute, etc. (M.S., 6/1/51). Satisfaction 4 December, of debenture registered 4 March, 1950.

NORTH EASTERN SCIENCE SUPPLIES, LTD., Sunderland. (M.S., 6/1/51). Satisfaction 28 November, of charge registered 22 February, 1950.

RENTOKIL, LTD., Leatherhead, manufacturers of insecticides, etc. (M.S., 6/1/51). Satisfaction 6 December of debenture registered 22 August, 1947.

#### Increase of Capital

The capital of SPA DRUG CO., LTD., St. George's Works, John Brown Street, Bolton, has been increased from £500 to £1000.

### New Registrations

#### British Potash Development Co., Ltd.

Private company. (489,734). Capital £300,000. Objects: To develop, extend and carry on the winning of potassium, sodium and magnesium salts and other minerals, metals, lodes, ores and other raw materials, etc. Subscribers: M. J. Wordley and F. M. Baxter. Solicitors: Linklaters & Paines, 6 Austin Friars, E.C.2.

#### C. Spencer (Graduating), Ltd.

Private company. (489,577). Capital £750. Objects: To acquire the business of graduation of scientific glassware now carried on by Claude Spencer at 136 Cambridge Road, Seven Kings, Essex, as "Claude Spencer." Directors: F. Spencer and C. Spencer. Reg. office: 136 Cambridge Road, Seven Kings, Essex.

#### Cardew Products, Ltd.

Private company. (489,602). Capital £500. Objects: To acquire the business of chemical manufacturers, bottlers and distributors carried on by Reginald T. Cargill and Frank E. Drew as "Rainham Chemical Company" at Front Lane, Cranham, Essex. Directors: R. T. Cargill and Frank E. Drew. Reg. office: 79 Upminster Road, Hornchurch, Essex.

#### C.M.W. Laboratories Ltd.

Private company (489,748).—Capital £5000. Chemical manufacturers chemists, etc. Directors: P. Hawtin, A. B. Blackhurst and J. Osborne. Solicitors: Blackhurst, Parker & Co., Blackpool.

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## The Stock and Chemical Markets

**T**HE beginning of the New Year found stock markets cautious and quiet with no very definite trend apart from renewed buying of rearmament shares. British Funds have been quite well maintained although there is some uncertainty whether the gilt-edged market will suffer a reaction next month when the £300 million of steel nationalisation stock is due to be issued.

Much will, of course, depend on the trend in steel stock when dealings start. There may be a good deal of selling by owners of steel shares who do not wish to hold additional Government stock in this form. On the other hand, buyers for steel stock would quickly come in if the price were to recede to an extent which gave a yield above that on other gilt-edged stocks with similar redemption dates.

Rising prices of commodities and goods, combined with the expectation that the next Budget will bring still higher taxation, have kept industrials subdued. Chemical shares were inclined to attract more business partly due to the industry's share in rearmament. Imperial Chemical strengthened to 42s. 6d., Monsanto were 50s. 3d., Laporte Chemicals 5s. units 10s. 6d., Albright & Wilson 30s. 6d. and F. W. Berk 12s. 6d. Boake Roberts kept steady at 38s. Elsewhere, Bowman were 5s. 9d. and Amber Chemical eased further to 2s. 3d. Brotherton were 21s. 3½d., Pest Control 7s. 3d. and L. B. Holliday 4½ per cent preference 19s. 6d. Fisons were 25s. 6d.

Shortage of zinc oxide affected sentiment in regard to paint shares which suffered sharp reactions following their recent strength. Lewis Berger were back to 32s., Pinchin Johnson to 39s. 1½d. Goodlass Wall to 39s. 3d. and International Paint to 15s. 6d.

There was a general rise in shares of companies making plastics, because the latter can be used as a substitute for metals and some other materials now in short supply. Buying was, however, only moderate. Paint shares showed some sharp declines, but have not been subject to any heavy selling.

Among plastics, British Xylonite led with a rise of 5s. at 92s. 6d. Erinoid were 2s. up at 9s. 4d. and Kleeman shares advanced to 13s.

United Molasses have been active around 28s. in anticipation of share bonus. The 4s. units of the Distillers Co. have been steady at 19s. 4d. Associated Cement at 50s. 6d. were little changed by the news

of higher cement prices. British Plaster Board 5s. units were 14s. 3d.

Turner & Newall have been maintained at 85s. Borax Consolidated strengthened to 56s. 6d. on higher dividend hopes, although payment is expected to be limited to last year's rate. United Glass Bottle at 77s. 6d. remained firmly held and unchanged in price. Higher dividend possibilities, are hoped for sooner or later. Triplex Glass at 26s. 1½d. have been quite well maintained. Boots Drug were 48s. 3d. and Glaxo Laboratories remained active around 59s.

Dunlop Rubber at 54s. 9d. made a small response to the higher tyre prices, and British Glues and Chemicals 4s. shares firmed up to 22s. 6d. Lever & Unilever again changed hands around 41s. 3d. Oils have been uncertain with Anglo-Iranian lower at 5½ and Ultramar Oil active at slightly over 21s. Shell were steady at 66s. 3d. anticipating the interim dividend.

### Market Reports

**T**HE turn of the year has witnessed a substantial activity in the industrial chemicals market with most sections reporting an increasing pressure for supplies. Questions of chief concern at the moment are the shortage of sulphur, the non-ferrous metal position, particularly zinc, and the acute shortage of drums. The high cost of imported drums is an added burden on the industry and the temporary lifting of the import duty is long overdue. Owing to a rise in the cost of the metal, zinc oxide prices have also been increased and red seal is now £170 per ton, green seal £171 10s. per ton and white seal £172 10s. per ton for two-ton lots delivered. The price of lithopone was advanced as from 1 January to £54 per ton. Brisk trading conditions have been resumed in the coal tar products market after the holiday dullness and supplies of most items are well sold in advance. Prices remain unaltered on the week.

**Manchester.**—There has been a fairly satisfactory resumption of trading operations on the Manchester chemical market following the holiday interval. Textile and other leading consumers of heavy products have been calling for steady deliveries, although at present only a moderate amount of new business has been placed. This, however, is expected to improve during the next few days. Most heavy and light tar products are in good demand.

### Canadian Insecticide Shortage

A shortage of raw materials which go into the production of insecticides may be responsible for reducing Canada's crop next year through inadequate pest control. This was stated recently by scientists of the agricultural chemicals division of Canadian Industries, Ltd. There are three factors threatening the supply problem. First, there is a shortage of chemicals and metals important to the production of insecticides, notably chlorine, benzene, copper and lead. Secondly, there is the difficulty of estimating accurately the probable regional and over-all insecticides needs because the tendency of many farmers is to delay purchases until pest damage is serious and the need for insecticides becomes urgent. Finally, the level of insecticide stocks at the ends of the 1950 crop year, which is exceptionally low.

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**EXPERIENCED ENGINEER**, with Degree standard in Mechanical, Heating or Chemical Engineering, required as Technical Assistant by leading Chemical Engineering Firm for design and calculations on heat transfer problems and also preparation of tenders, commissioning of plant and technical sales. Previous experience and proven ability in similar work essential. This is a permanent and progressive appointment. Residence in London area necessary. Write, stating age, experience and salary expected, to Box No. C.A. 2967, THE CHEMICAL AGE, 154, Fleet Street, London, E.C.4.

**EXPERIENCED PRODUCTION MANAGER** required for Midland Works manufacturing Chemical Foundry Supplies. Write, in confidence, stating fullest particulars of age, experience, etc., to Box No. C.A. 2962, THE CHEMICAL AGE, 154, Fleet Street, London, E.C.4.

**oIL Refinery Contractors** handling large contracts for Refinery Plant, require **CONTRACT ENGINEERS** in their London Office. Duties involve broad direction and co-ordination of all phases of the work, including planning, drafting, purchasing, progressing and erection. Desirable qualification is previous experience of Refining Industry or Heavy Engineering, including a wide knowledge of pumping, heat-exchange equipment and instrumentation, and the appointment offers excellent prospects to suitable men. Applicants should write fully, stating qualifications, age and experience, to **Foster Wheeler, Ltd., 3, Ixworth Place, London, S.W.3.**

**WORKS CHEMISTS AND TECHNICAL ASSISTANTS** are required by the Division of Atomic Energy (Production) at Windscale Works, Sellafield, Cumberland, and Springfields Factory, Salwick, nr. Preston. The work involves the control of novel and complex chemical processes, many of which are still under development. Candidates must have either an Honours Degree in Chemistry, Metallurgy or Chemical Engineering, Associateship of the Royal Institute of Chemistry, or the Institution of Metallurgists, Corporate Membership of the Institute of Chemical Engineers, or equivalent qualifications. Candidates need have no specialised knowledge of the chemistry of radio-active elements. Facilities exist for training in factory administration and there will be opportunities for promotion.

Salary for Works Chemists will be assessed according to age and experience, within the range £330-£720 per annum, and for Technical Assistants according to age, within the range £330-£570 per annum.

Applications to **Ministry of Supply, D.A.E. (P.), Risley, nr. Warrington, Lancs.**, stating post applied for and location preferred.  
RS.3305-JO-20.

## SITUATIONS VACANT

**PLANT DEVELOPMENT AND PROCESS ENGINEERS**, qualified in Chemical Engineering or Petroleum Refining Technology, required by Bahrain Petroleum Company, Limited. Age limit, 25-40. Two-year agreement periods with passages and paid leaves. Free air-conditioned accommodation, board and medical attention, kit allowance, low living costs. Salary according to experience. Write, with full particulars of age, education, experience, to Box 3784, c/o Charles Barker & Sons, Ltd., 31, Budge Row, London, E.C.4.

**T**HE Civil Service Commissioners invite applications for a permanent appointment as **PRINCIPAL SCIENTIFIC OFFICER** at the Atomic Energy Research Establishment, Harwell, Nr. Didcot, Berks., to lead a team engaged on problems of fundamental chemical engineering interest.

Candidates must have a 1st or 2nd Class Honours degree in chemical engineering or chemistry of equivalent professional qualifications, with several years research experience. They should also have a considerable knowledge of the underlying theory of chemical engineering unit operations, especially the diffusional processes (heat transfer, absorption, distillation, solvent extraction, etc.). Some experience in chemical plant design and/or operation is desirable although not essential.

Exceptionally other candidates of high professional attainment may be admitted.

All candidates must have been born on or before 1st August, 1920.

Salary scale (male) £980-£1,295. Rates for women somewhat lower. The post carries benefits under Federated Superannuation System for Universities.

Good housing prospects for selected candidate, if married.

Further particulars and application forms from: Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1. quoting No. 3430. Completed application forms must be returned by 30th January, 1951.  
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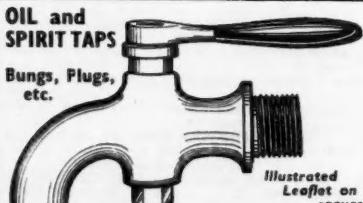
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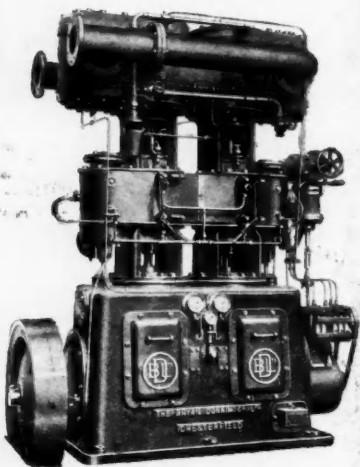
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